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COAST ARTILLERY FIELD MANUAL



ANTIAIRCRAFT ARTILLERY OPERATION OF MATÉRIEL AND EMPLOYMENT OF PERSONNEL SEARCHLIGHT UNITS

December 9, 1942

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FM 4-175

COAST ARTILLERY FIELD MANUAL

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ANTIAIRCRAFT ARTILLERY OPERATION OF MATÉRIEL AND EMPLOYMENT OF PERSONNEL

SEARCHLIGHT UNITS

change 1, Mar 27, 43



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1942

WAR DEPARTMENT,
WASHINGTON, December 9, 1942.

FM 4-175, Coast Artillery Field Manual, Antiaircraft Artillery, Operation of Matériel and Employment of Personnel, Searchlight Units, is published for the information and guidance of all concerned.

[A. G. 062.11 (10-6-42).]

BY ORDER OF THE SECRETARY OF WAR:

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DISTRIBUTION:

R and H 1 (2); Bn and H 44 (5); IBn and H 4 (3); IC 4, 44 (25). (For explanation of symbols see FM 21-6.)

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RESTRICTED**COAST ARTILLERY FIELD MANUAL****ANTIAIRCRAFT ARTILLERY****OPERATION OF MATÉRIEL AND EMPLOYMENT
OF PERSONNEL****SEARCHLIGHT UNITS**

(This manual supersedes FM 4-115, June 20, 1940, including Changes No. 1, July 15, 1941.)

CHAPTER 1**GENERAL**

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SECTION I. General.....	1-4
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SECTION I**GENERAL**

■ 1. SCOPE.—This manual is designed for use by antiaircraft searchlight units as a guide in the handling of matériel, selection of personnel, employment of practical training methods, and service of the piece. Drills and instructions given pertain especially to the later types of matériel M1941 and M1942.

■ 2. REFERENCES.—This manual should be studied in conjunction with the references listed in the appendix. The references include visual aids as well as textual materials.

■ 3. EQUIPMENT.—a. The present standard system for the detection, location and illumination of targets includes the following equipment, the arrangement of which is shown schematically in figure 1.

- (1) Detector.
- (2) Power trailer.

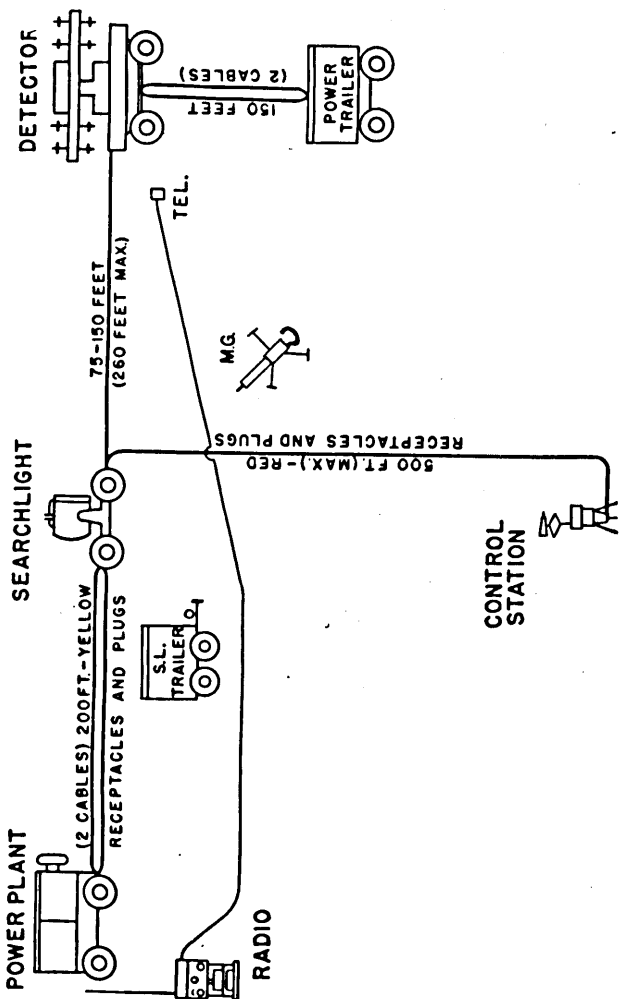


FIGURE 1.—Field emplacement of equipment of detector-searchlight section.

- (3) Searchlight.
- (4) Power plant.
- (5) Control station.
- (6) Connecting cables.

b. In the present Tables of Organization, each of the three detector-searchlight sections (the three detector sections combined with three searchlight squads) of the searchlight platoon are equipped with detectors. The two additional searchlight squads are not so equipped.

c. Figure 1 is a schematic diagram showing an arrangement of detector-searchlight matériel as limited by cable lengths. The power plant may be located up to 200 feet from the searchlight, and the detector may be located up to 260 feet from the searchlight. The detector is set up as near as practicable to the searchlight (usually 75 to 150 feet), as there is no provision at the detector for a parallax correction for the displacement between the light and the detector. The detector power trailer may be located within 150 feet of the detector. The location of the control station is limited to within 500 feet of the searchlight by the length of the cable. However, local terrain conditions will usually determine the field lay-out. The connecting cables between each element are shown in figure 1 as follows:

- (1) Power cables from power unit to searchlight (yellow plugs and receptacles).
- (2) Data transmission cable from detector to searchlight (cable fits into blue receptacle at searchlight).
- (3) Distant electric control cable from the searchlight to the control station (red plugs and receptacles).

■ 4. POSITION FINDING.—The antiaircraft searchlight unit must determine the present position of a hostile target in order to direct or point the searchlight at the target. This present position is located by means of a radio detector which determines the azimuth and angular height of the target and simultaneously transmits these directional data to the searchlight by a self-synchronous transmission system. (See FM 4-145.) For those units still equipped with sound locators for position finding see TM 9-1660 and 9-2660.

SECTION II

ANTI-AIRCRAFT SEARCHLIGHT PROBLEM

■ 5. GENERAL MISSIONS.—The mission of anti-aircraft artillery searchlights is to discover and illuminate hostile targets operating during darkness in order that anti-aircraft artillery may fire on them effectively, or to illuminate hostile aircraft for interception by friendly fighter aviation.

■ 6. FACTORS OF ILLUMINATION.—*a.* The effective performance of searchlights in supplying artificial illumination is dependent upon a number of *internal* and *external* elements.

b. Internal elements are those which depend on the searchlight and which control its luminous output. The principal internal elements are as follows:

(1) Illumination intensity and power of the arc which is the source of light.

(2) Diameters of the crater and the reflector.

(3) Position of the source with respect to the focus of the reflector.

(4) Efficiency of reflection of the reflector and that of other searchlight parts.

(5) Sputtering or unsteadiness of the arc.

(6) Light absorbing deposits on the mirror and front door glass.

c. External elements are those which act on the luminous output after the projection of the beam of the searchlight. The principal external elements are as follows:

(1) Distance of the target from the searchlight.

(2) Absorption of the atmosphere.

(3) Dimensions and the characteristics of the target.

(4) Position of the observer.

(5) Visual acuity and use of optical glasses.

d. For detailed discussion of the influence of these various elements upon the effectiveness of searchlight illumination, see the Operator's Manual for the light with which the unit is equipped.

CHAPTER 2

ORGANIZATION

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SECTION I

DETECTOR-SEARCHLIGHT SECTION

■ 7. COMPOSITION.—A detector-searchlight section is formed when, for tactical purposes, a searchlight receives data from a radio detector. In this situation, the section comprises the personnel necessary to man one complete searchlight unit: detector, searchlight, control station, power plants, radio, machine gun, and vehicles. The detector-searchlight section is organized as follows:

a. The chief of section of the detector section acts as chief of the combined detector searchlight section.

b. The detector section consists of the chief of section, the range operator and—

No. 1, azimuth operator.

No. 2, elevation operator.

No. 3, keyer, modulator attendant.

No. 4, power plant operator.

No. 5, chauffeur of mount prime mover (assistant operator).

No. 6, chauffeur power trailer prime mover (assistant operator).

No. 7, antiaircraft lookout (assistant operator).

No. 8, assistant operator.

c. The searchlight squad consisting of the searchlight commander, acting as control station observer and—

No. 1, controller, azimuth (operator, control station).

No. 2, controller, elevation (operator, control station).

No. 3, operator, searchlight.

- No. 4, operator, power plant, and chauffeur, truck No. 2.
- No. 5, chauffeur, truck No. 1.
- No. 6, operator, telephone.
- No. 7, basic.

■ 8. FORMATION.—*a.* As illustrated in figure 2, each detector-searchlight section assembles in two ranks with 4 inches between the files, and 40 inches between ranks. There is an interval of 1 pace between the detector section and the searchlight squad. Within each group, men form in numerical order with odd numbers in the rear rank and even numbers in the front rank. The post of the chief of section is in the front rank of the detector section 1 pace to the right of the range operator. The post of the searchlight commander is in the front rank of the searchlight squad, covering No. 1 of that squad.

b. When setting up, operating, and loading the equipment, the men normally move at ease, and in such formations as permit the most efficient handling of the equipment. The posts of the crews of the detector section and of the searchlight squad are shown in figure 3.

SECTION II

SEARCHLIGHT PLATOON

■ 9. COMPOSITION.—*a.* The antiaircraft searchlight platoon is composed of a headquarters section, three detector sections and five searchlight squads. For tactical operations, the elements of the searchlight platoon are organized into three detector-searchlight sections and two searchlight squads. The section sergeant in each detector section acts as chief of the combined detector-searchlight section.

b. The platoon headquarters section contains the platoon commander and certain personnel necessary to furnish technical advice and assistance to the detector sections and searchlight squads on the maintenance and repair of searchlight and detector matériel; personnel to establish and operate the platoon wire and radio communication nets; and chauffeurs for platoon headquarters section vehicles.

■ 10. FORMATION.—The searchlight platoon assembles with the platoon headquarters section on the right, three detector-searchlight sections and two searchlight squads on the left, at 4-pace intervals. The sections and squads are numbered from right to left. The platoon commander takes post 6 paces in front of the center of the platoon. Figure 4 shows the formation of the antiaircraft searchlight platoon.

SECTION III

SEARCHLIGHT BATTERY

■ 11. COMPOSITION.—*a.* Antiaircraft searchlight platoons are combined, in units of two platoons with a battery headquarters, to form antiaircraft artillery searchlight batteries.

b. For further details of organization, see FM 4-105 and appropriate Table of Organization (T/O 4-38, 4-138, or 4-168).

■ 12. BATTERY COMMANDER.—*a.* The battery commander is responsible for the efficiency, training, and administration, including supply, of the battery and for the condition of the matériel assigned to it.

(1) He supervises the maintenance, technical operation, and supply of the searchlight and the detector equipment.

(2) He is responsible for the illumination of all hostile targets operating within effective range of the lights.

b. When directed by higher authority, he selects and coordinates the general locations for the lights. The selection of the exact locations for the lights is usually made by the platoon commander concerned.

SECTION IV

SEARCHLIGHT BATTALIONS

■ 13. COMPOSITION.—*a.* Antiaircraft searchlight batteries are combined, with the addition of a headquarters battery, into searchlight battalions.

b. Searchlight battalions which are a part of antiaircraft regiments contain two searchlight batteries and a headquarters battery.

c. Separate searchlight battalions contain three searchlight batteries and a headquarters battery.

d. For further details of organization, see FM 4-105 and appropriate Table of Organization (T/O 4-35, 4-135, or 4-165).

■ 14. BATTALION COMMANDER.—See FM 4-105 and 101-5 for duties and responsibilities of the searchlight battalion commander and his staff.

■ 15. HEADQUARTERS BATTERY.—See FM 4-105 for a discussion of headquarters batteries in antiaircraft artillery units.

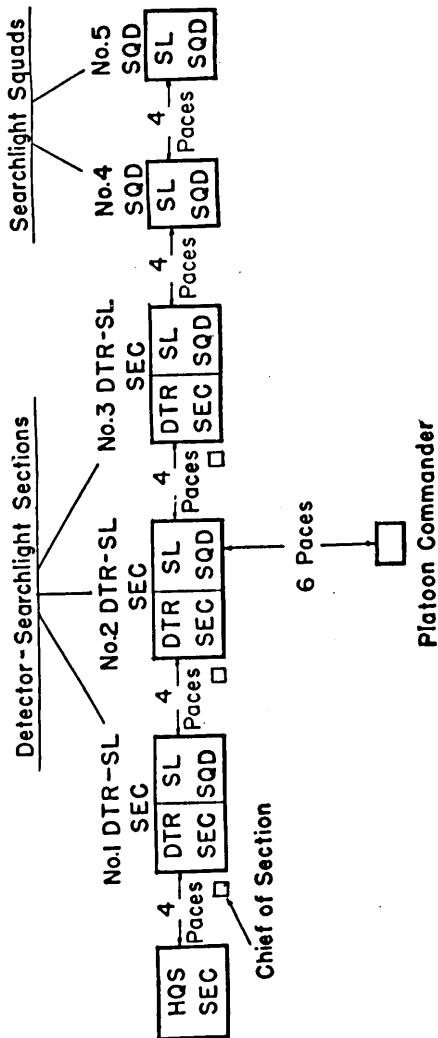


FIGURE 4.—Formation of antiaircraft searchlight platoon.

CHAPTER 3

TRAINING

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SECTION I

GENERAL

■ 16. SCOPE.—This chapter contains suggested methods of selection and training of personnel designed to secure rapid and efficient illumination of suitable aircraft targets, and to accomplish the other missions of antiaircraft artillery searchlights.

■ 17. IMPORTANCE.—Most of the active countermeasures against night flying aircraft, both by fighter aviation and antiaircraft artillery, depend on searchlights for the illumination of their targets. This illumination is a valuable component in an elaborate system of air and ground antiaircraft defense.

■ 18. TARGETS.—*a.* Antiaircraft searchlights are primarily designed to illuminate aircraft flying at medium and high altitudes—normal targets for the antiaircraft gun batteries. One of their additional missions may be to illuminate low-flying aircraft—those which are the normal target for automatic weapons. Primary targets must be illuminated at such a distance from the objective as will permit the fire control instruments of the gun batteries involved to pick up the target and track it, and the guns to open fire so that the first shells burst within the maximum effective range of the guns.

b. Antiaircraft searchlights also cooperate with friendly aviation by illuminating targets for fighter aircraft, enabling the friendly fighter to intercept and attack the enemy.

■ 19. LOCATING THE TARGET.—The target is rapidly and accurately located by a detector which causes the searchlight to be directed to the azimuth and elevation of the target. The theory underlying this method of target location is discussed in FM 4-145.

■ 20. SELECTION AND TRAINING OF PERSONNEL.—Efficient operation of searchlight matériel requires that personnel be carefully selected and thoroughly trained. A maximum of initiative, sound judgment, and technical knowledge is required of all men in searchlight units, and this fact should be made the basis for the training methods followed. In order to allow for inevitable losses due to promotion, sickness, and casualties, each key man must have at least one understudy trained as his replacement. Training should include the assignment of personnel of the searchlight squad to duty with the detector unit, and the detector operators should be given experience in the performance of the duties of the searchlight squad. Such a rotation of personnel at the various stations not only prepares the men for emergency duties in the field, but also improves morale, relieves the monotony of a never-changing duty, and promotes efficiency and appreciation of the part each element of the equipment plays in the success of the unit as a whole. Moreover, a shifting of assignment supplies the men with the wider knowledge which is necessary for the making of sound decisions under stress.

■ 21. PHASES.—The training of personnel is divided into four phases: individual training, section training, platoon training, and battery and battalion training. In the first phase, individuals are perfected in the technique of their individual duties and as replacements for other assignments. In this first phase, only the training of the personnel of the searchlight squad is covered in this manual. For individual training of the detector section, see FM 4-145. In the second phase, the men manning one searchlight unit (detector, searchlight, control station, power plants, radio, machine gun, and vehicles) learn to work together as a team. In the third phase, the light units composing a platoon work together as a team to pick up and carry single and multiple airplane targets. For the fourth phase, the operation of the search-

light units within the platoons are coordinated with a unified plan for the defense of an area, or the accomplishment of other missions as determined by the battalion or regimental commander.

SECTION II

INDIVIDUAL TRAINING

■ 22. GENERAL.—Thorough basic training for individuals is the fundamental key to efficient performance of searchlight units. In the early stages of training, the emphasis should be put on learning the correct method rather than present accuracy or success. Training should be planned in progressive stages. The attempt of poorly trained personnel to illuminate unlighted airplanes will tend to discourage the men, will cause their training to be inefficient, and will delay their progress.

■ 23. CONTROL STATION OPERATORS.—*a.* The *azimuth and elevation controllers* should be trained to keep the searchlight pointed as indicated by the detector. This is accomplished by using the handwheels to keep the zero readers centered. These operators should be cautioned to avoid radical movements and to smooth out any sudden movements called for by the zero readers. They must be taught complete reliance upon the accuracy of the detector data, and upon the ability of the detector crew to supply the data which will place the beam on the target. Above all, they should depend on the detector data rather than seek a flick by a wide and rapid search. They search for the target by *slowly* and *smoothly* moving the zero reader pointers first to one side and then to the other side of the zero mark. They immediately relinquish control of the handwheels to the searchlight commander as soon as a flick occurs and at the command FLICK.

b. The *searchlight commander* (generally a noncommissioned officer) looks through the binoculars and directs the search for the target, if a search is necessary. He looks constantly along his beam, never disturbing the focus of his eyes by looking down at the zero readers. He should be instructed as to the smallness of the area of error through which the controllers search. This area of error will not

exceed 2° (searchlight beam spread is $1\frac{1}{4}^{\circ}$) for elevation and for azimuth. The detector is sufficiently accurate to cause the searchlight beam to pass through the target position at least once every 2 or 3 seconds. With a well trained unit, "zero" pick-ups (beam squarely on target when light goes into action) may be expected. The searchlight commander is shown how to use the binoculars on the control station in an active search and how to carry the target after it is picked up. He should be instructed as to the importance of a *slow* and *careful* search, as many unseen flicks are made because the search was too fast and the flick too short. He must realize with what speed the end of the beam sweeps through the sky when the light is turned even quite slowly through a small angle.

c. Situations will arise in which, because of haze, the target cannot be tracked visually because it cannot be seen from the light position. However, if the beam is directed on the target, it may be assumed that some light will filter through the haze and give partial illumination of the target. Such illumination is very effective when using searchlights with fighter airplanes. Although the illumination would not be apparent from the ground, it would be an aid to the fighter pilot in locating the enemy bomber.

d. The searchlight commander should be well trained in the identification of friendly and hostile aircraft. By the use of his binoculars, during both day and night, he has an excellent opportunity to identify airplanes, and report this intelligence to higher command.

■ 24. SEARCHLIGHT OPERATORS.—a. The searchlight operator should be trained in all the details pertaining to the functioning of the searchlight (see Operator's Manual). He should be taught the prescribed method of—

- (1) Leveling the light.
- (2) Orienting and synchronizing the light.
- (3) Striking the arc.
- (4) Adjusting the arc length.
- (5) Maintaining the proper protrusion of the positive carbon.
- (6) Adjustment of the beam by the use of the focusing knob.

(7) Keeping the arc voltage and current at the proper values.

(8) Recarboning the light.

(9) Using hand controller for movement of light in azimuth and elevation.

(10) Cleaning the light.

(11) Lubricating the light.

b. It is important that the light operator be given sufficient instruction and drill on the manual control of the searchlight and its arc, in order that the change from automatic to semi-automatic or manual control may be made without confusion and loss of efficiency.

c. It is also of high importance that the searchlight operator be thoroughly trained in the preparation of the light for movement to a new position. Serious breakage and injury to equipment often results from improper procedure in preparing and securing the light for march order.

d. The searchlight operator, as well as all personnel, should demonstrate pride in his equipment. The vital importance of maintenance of the searchlight should be stressed in training, so that the operator will believe that a "well-serviced light never fails."

■ 25. POWER PLANT OPERATORS.—a. Each power plant operator is first trained in the mechanics of starting, running, and stopping the power plant engine. He is then trained to operate the power panel and to keep the power plant in good operating condition.

b. He is thoroughly trained in the manual operation of the power plant to insure its continued operation in case the automatic devices fail. Manual operation requires frequent practice and a high degree of mechanical skill to operate the power unit efficiently.

c. Detailed directions for power plant operation are found in the Operator's Manual for the searchlight with which the unit is equipped.

■ 26. CHAUFFEURS.—a. The majority of enlisted men today have had some experience in driving an automobile. They should be first taught the difference between a passenger car and the truck they are to operate. The difference in height

and length should be pointed out so that they will not attempt to drive the truck through an opening too small for it. The greater length will make it impossible to get around hairpin turns easily negotiated with a car. The greater weight calls for greater care as to the bridges and muddy roads used.

b. Chauffeurs must be trained to understand methods to be used in towing the trailer and power plant. They must be familiar with operation of the safety devices and the break-away feature of these towed vehicles. Drivers should be cautioned against backing up their vehicles, except when there is no other choice. Training of chauffeurs should also include blackout driving and air raid discipline.

c. New chauffeurs should be taught the care and preventive maintenance of the truck and trailer—how to replace gasoline, oil, water, battery water, and air in the tires of the truck; how often to check these items; and how to lubricate the truck and trailer. (See FM 25-10, TM 10-460, and 21-300.)

d. They should be given an understanding of what *not* to do; they should not adjust the carburetor, adjust the breaker points, clean the spark plugs, or attempt to make other repairs normally attended to by the battery maintenance section, except in case of emergency.

■ 27. TELEPHONE OPERATORS.—a. The primary qualifications for a telephone operator (or remote control radio operator) are good hearing and the ability to speak clearly and intelligently. Most men do not have the second qualification naturally, but must be trained in speech. The pronunciation of numbers for telephone use ("thuh-ree" for three, "fi-yiv" for five), the use of words to indicate letters of the alphabet ("Baker" for B) and, in general, procedure for efficient telephone operation as given in FM 24-5, should be included in the training.

b. One of the best men in the squad should be chosen as telephone operator. He should have an even temperament, common sense, and the ability to keep cool under stress. Numerous messages come over the telephone or radio, so he must, without confusion, select the order directed to his own unit.

c. In addition to the general training mentioned above,

the operator should be afforded a great deal of practice in the use of words, commands, and warnings usually employed in the searchlight platoon. A series of hypothetical commands, warnings, and messages simulating actual operations will help the new operator to become familiar with the type language used by the searchlight organizations. Such typical messages are often included in training memoranda prepared by the battalion or higher command.

d. As speed is the most important factor in antiaircraft communication, the operator does not ordinarily record the message received, but repeats the message orally as it comes over the wire. Similarly, messages from the chief of section to the platoon command post are not recorded but are repeated as given by the chief of section. Exception is made in the case of administrative messages (messages relating to supplies, repairs) where speed is not a consideration, and a copy of the message is desired.

e. A general idea of how the telephone works and how to make simple repairs should be given the operator. He should have practice in diagnosing simple troubles in the telephone line and in recognizing the symptoms of a short circuit, an open circuit, a ground, or other source of trouble. (For details, see FM 24-5.)

f. If the searchlight unit has been issued a two-way radio and remote control unit, the telephone operator will set up the radio near the searchlight power plant and prepare it for communication. By use of a headset and microphone he will tune to the proper frequencies for communication with other units. He will operate the radio and the remote control unit in order to transmit messages from and receive messages for an operator (remote control telephone operator) at a field telephone near the chief of section (or searchlight commander for squads not equipped with detectors). Because the telephone operator is responsible for radio communication and for the operation of the remote control unit, he should be instructed in the *specific* duties which he will be required to perform in this assignment. For a detailed explanation of the training of a radio operator, see TM 11-454.

SECTION III

DETECTOR-SEARCHLIGHT SECTION TRAINING

■ 28. SCOPE.—The training of the searchlight-detector section should provide instruction in the teamwork of operating one complete searchlight unit efficiently.

■ 29. METHOD.—*a.* Given proper individual training, the most important factor in the efficiency of a searchlight unit is constant practice. This drill must be at regular intervals and cover all the different situations the unit is likely to encounter in action. Drills are necessary not only to provide quick pick-ups and smooth tracking, but also to give light commanders ample opportunity to command. If drill is infrequent, light commanders will be too slow in grasping the situation when multiple targets must be illuminated.

b. The importance of frequent practice at regular intervals cannot be overemphasized. It has been found that a break of a few days in training seriously lowers the efficiency of a unit. To prevent these breaks in training, the unit commander must use all possible ingenuity. Training devices for the detector operators, the use of specially prepared balloons as targets, and military airplanes must constantly be employed to fill in the periods when no regular drills or assigned targets are possible.

c. Enthusiasm and efficiency in training may be promoted among the men by making clear to them the new missions of searchlights, their vital service in the solution of the antiaircraft artillery problem, and the superiority of modern matériel.

■ 30. CHIEF OF SECTION.—As the chief of section of the detector section acts as chief of the combined detector-searchlight section, he must be carefully trained so as to operate his unit properly. His training should include the subjects listed below:

- a.* Assembly and disassembly of the detector.
- b.* Selection of a good detector-searchlight position.
- c.* General principles of the operation of the detector for

determining the position of the target by means of a radio echo.

d. Illumination phenomena, or the internal and external elements which affect illumination.

e. General principles of the electric circuits which operate the searchlight—the arc circuit, the zero reader circuits, and the distant electric control circuits.

f. Orientation and synchronization of searchlight unit equipment.

g. Map reading is essential, as the chief of section must be able to tell from a map—

(1) How to get to a position marked on the map, or the coordinates of which are given.

(2) Whether a road is too steep for his vehicles to climb.

(3) Whether a nearby knoll is high enough to blanket a prospective light position.

h. Tactics and speed of modern aircraft of the different types.

■ 31. SEARCHLIGHT COMMANDERS.—a. The principal emphasis in the training of the searchlight commander should be placed on the limited search which must be made to pick up the target. He should know enough about illumination phenomena to understand why a search through several degrees beyond the width of the beam may be necessary and why it is important that the controllers search slowly.

b. He should know enough about the design and functioning of the searchlight, control station, and power plant to supervise their operation and routine maintenance.

c. He should realize the importance of the greatest accuracy in leveling and orientation, and in checking the electrical and data line connections.

d. He should be thoroughly instructed as to the proper time for going into action, going out of action, and changing target under various conditions, and should have a complete grasp of the problem of his platoon in order that he may act with intelligence and decision under LIGHT COMMANDER'S ACTION. In the normal field situation and particularly under the stress of multiplane attacks, the searchlight commander must act according to his own judgment and initiative. In such con-

stantly varying situations, the split-second decisions that mean success must be made by the light commander.

e. He should be so trained as to be able to take over the duties of the chief of section, should this become necessary.

■ 32. DETECTOR OPERATORS.—On a normal course, the operators will find that events occur in the following sequence:

a. The chief of section may receive intelligence from the Antiaircraft Artillery Intelligence Service or the Aircraft Warning Service of the approach of a target, and its general location as to azimuth and slant range.

b. If the report indicates that the target is within the searching sector (30° to 90°) assigned that unit, the chief of section directs the detector operators to move the direction-finding arrays to the general direction indicated and to search in that general vicinity. If the target is now within range of the detector, the azimuth and the angular height of the target are determined by the detector, and these data are continuously transmitted to the searchlight.

c. Many times advance information of the approach of hostile aircraft will not be available to the searchlight unit. The detector operators, however, are constantly searching within the searching sector assigned to that section, and they should be able to pick up the target at the maximum range of the detector. When the detector mount is on the target, data are continuously transmitted to the searchlight.

d. When the target is within range of the searchlight and upon the direction of the platoon commander, or upon his own initiative, the chief of section gives the command IN ACTION (normally by voice) and the light is turned on. The control station operators search through a small area in order to pick up the target. During this searching period, the detector operators continue as before, sending directional data to the control station. When the target is flicked, the searchlight commander carries the target by the use of his binoculars.

e. The detector operators then cease tracking and turn the detector toward the front, ready to pick up another target.

f. At the command OUT OF ACTION, the light is put out.

■ 33. CHAUFFEURS.—*a.* Advantage will be taken of every opportunity to train drivers as they drive their vehicles from place to place during the training of the section.

b. During this training, the chief of section will have ample opportunity to point out the necessary expedients to the new chauffeurs. The mechanics of how best to drive when operating without lights, how to back up in order to pick up the equipment (if backing must be done), and how to turn around in a restricted space, should all be practiced during this period.

c. If the conditions for actual practice are not favorable, thorough instruction is given the chauffeurs in driving over difficult terrain. They are taught how to approach roads rutted with mud, sand, and gravel, and how to maneuver in rocky and scrubby cross-country driving. They are trained to estimate quickly and accurately the road clearances of truck, trailer, and power plant, to overcome side hills, hummocks, and outcroppings, and to judge attempts at ditches, ravines, and waterways. They are taught the proper use of lower gear ratios and the distinction in driving between speed and caution.

d. The importance of camouflage is pointed out and practice is given in selecting suitable parking places where natural camouflage is sufficient. Practice in artificially camouflaging the truck and trailer should be given. For more detailed instructions see FM 4-105 and 5-20.

■ 34. OTHER MEMBERS.—The training of the other members of the section is devoted to fitting the skill they have acquired in individual training into the teamwork of the unit. Their training is not dependent upon an aerial target and can be carried on almost as well indoors as out and in daylight as well as dark.

■ 35. INDOCTRINATION OF PERSONNEL.—*a.* The whole searchlight organization depends on the accuracy of the detectors for its efficiency. To use the searchlight team at its maximum effectiveness it is necessary that all concerned place their confidence in the detectors, and believe that the data sent from the detectors are accurate to a high degree. This matter is important enough to warrant a special daylight test or demonstration before the whole battery. For the

demonstration a whole unit is set up. The range operator and Nos. 1 and 2 of the detector section are closely supervised to insure that they keep their eyes on the sight tubes which are used with the dials during daylight drill. The searchlight is directed at an airplane by means of detector data. Personnel are now instructed to sight at the airplane through the daylight sights on the searchlight and observe the closeness of the line of sight to the target. Such a demonstration will usually convince all the men that detector data are highly accurate.

b. Mechanical sights (orienting), adjustable in azimuth and elevation, may be mounted on the detector. Operators may then orient with an airplane several times a day. When the electrical axis is on target (operators report on target), the mechanical axis should also be on target (airplane should be sighted through mechanical sights on detector mount).

■ 36. DAYLIGHT PREPARATION.—a. In order to train the entire section to function as a unit prior to working under the handicap of darkness, it has been found valuable to drill the section a number of times during daylight. Advantage should be taken of any nearby commercial air route, airport, military airport, or military air training area to furnish chance targets. Arrangements can often be made for airplane missions. For all such targets the procedure explained in paragraph 35a is recommended. The accuracy of the location of the target and the pointing of the light may be judged by looking through the daylight sights on the searchlight and seeing how near to the target the light is pointed.

b. If target airplanes are not available for daylight or night drill, specially prepared target balloons may be released at a considerable distance from the unit. The detector locates and tracks the balloon target, and the searchlight picks it up and carries it.

■ 37. NIGHT DRILL.—When the unit has undergone sufficient daylight training, night drill tracking of an airplane flying with its running lights on will be found an excellent method for developing efficiency and confidence, particularly in the first stages of night drill. The light is pointed by the detector

data at all times, and the control station operators follow these data constantly and continuously. As described in paragraph 35a, the men may sight the airplane through the light's daylight sights, and observe the accuracy of the detector as a direction finder.

SECTION IV

PLATOON TRAINING

■ 38. SCOPE.—The platoon training should instruct the light units in the teamwork of operating efficiently with other light units.

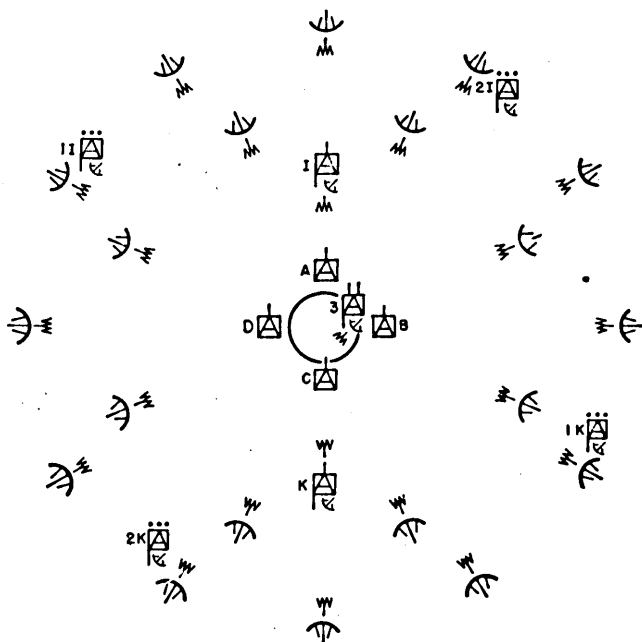
■ 39. PHASES.—The training of the platoon can be divided into two phases, primary and advanced.

a. The primary training phase affords an opportunity for the previously trained light units to work together in picking up a single target in the shortest possible time. Practice is the most important single factor. Night practice is best, but daytime practice is valuable.

b. The advanced training phase affords an opportunity to drill the light units in functioning under more difficult service conditions. Multiple targets, functioning without communication and while being attacked by low-flying bombardment, come under this classification.

■ 40. NORMAL SITUATION.—a. The normal set-up for a searchlight defense, including the distances between lights and their disposition in an outer ring of pick-up lights and an inner ring of carry lights, is described in FM 4-105. The normal communication net, both telephone and radio, and its relationship to the Aircraft Warning Service and the Anti-aircraft Artillery Intelligence Service is also outlined in the same manual (FM 4-105). Basic considerations in the design of a searchlight defense demand that gun battery locations determine the location of the searchlights. There is no assignment of searchlights to gun batteries, as these light units are operated under a general plan of illumination for the defense. The defense must be so arranged that it may act with effectiveness against air attack from any direction. One searchlight battalion is ordinarily required to afford an

all around defense of an objective 2,000 to 4,000 yards in diameter. The platoon command post is generally located at the center light in the forward line of pick-up lights.



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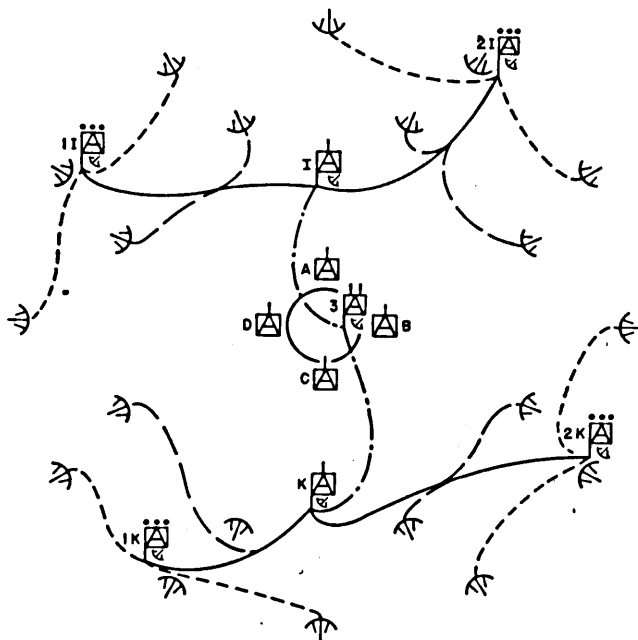
W RADIO COMMUNICATIONS

NOTE:- DETECTOR WITH EACH SL
IN OUTER RING OF LIGHTS

FIGURE 5.—Antiaircraft artillery defense of an objective by the gun and searchlight battalions of an antiaircraft artillery regiment (illustrating searchlight battalion radio net).

Figures 5 and 6 illustrate a typical plan for the antiaircraft artillery defense of an objective. Reports, or flash messages, are transmitted by radio from each detector-searchlight section to the regimental plotting board or other designated

central controlling agency for a coordinated defense. Control of the various sectors assigned to searchlight platoons



-LEGEND-

- LINES ESTABLISHED BY BATTALION
- 1ST LINES ESTABLISHED BY BTRY
- 2ND LINES ESTABLISHED BY BTRY
- 3RD LINES ESTABLISHED BY BTRY

} WIRE SUPPLY
} PERMITTING

NOTE: DETECTOR WITH EACH SEARCHLIGHT IN
THE OUTER RING OF LIGHTS

FIGURE 6.—Antiaircraft artillery defense of an objective by the gun and searchlight battalions of an antiaircraft artillery regiment (illustrating searchlight battalion telephone net).

for the illumination of targets is by the searchlight controller at the plotting board of the regiment or higher command.

b. A simple method which the platoon commander may use as a check upon the state of training of the light crews under his command is the construction of a pencil sketch or plot of the location of the pick-up and carry lights of the platoon. Distances between lights and between rings are drawn to scale, and assuming each pick-up light is oriented in azimuth referred to north, an azimuth scale graduated in increments of 400 mils is drawn in around each light. As each of these transmits data on target airplanes (as outlined in detail in par. 41) the map sketch can be used by the platoon commander to plot quickly the direction and range of the approaching target, and to check the efficiency and accuracy of the detector crews in picking up the target.

c. The platoon commander may exercise only general supervision over the action of his lights. It may be expected that smoother, more effective, more dependable functioning can be obtained under conditions of LIGHT COMMANDER'S ACTION.

■ 41. SEQUENCE OF EVENTS.—a. (1) If the searchlight platoon is part of a highly organized defense, it may secure advance information of the approach of enemy airplanes. This information will come through the Antiaircraft Artillery Intelligence Service or Aircraft Warning Service. If such information is not available, or if enemy airplanes elude detection, the platoon must depend on its own detectors to pick up the target at the maximum slant range of the detector. The remote control telephone operator or telephone operator of each detector unit will give the following data on all unidentified airplanes:

(a) Identification number of the post reporting (Light No. ———).

(b) Azimuth in mils (900).

(c) Slant range of target in thousands of yards (slant range 35).

(2) A specimen radio or telephone message would read, "Light No. 2, azimuth 900, range 35." By making a simple plot of the course of the target at platoon or battery command posts (see par. 40b) or a more accurate plotting of course of target on battalion or regimental operations boards (see par. 48), the location of the target is well fixed.

b. (1) When the chief of section of the nearest pick-up (forward) light estimates that the target is in a favorable position for the pick-up, he commands (on direction of the platoon commander): **IN ACTION**. If part of a large coordinated defense, the searchlight controller at the plotting board of a central controlling agency, such as a regimental or AAC plotting board, will alert the platoon sector. In this case the chief of section will not be directed by the platoon commander, but on release by the plotting board controller, will go into action just as soon as the target comes within the pick-up range of the light. The other pick-up lights in range go into action immediately, when released by the searchlight controller, and assist the first light to pick up the target.

(2) When the defense is trying to pick up two targets, the procedure is quite similar to that outlined above. The range operator of the detector section, in selecting a target under the direction of the chief of section, must be sure to select the target most nearly in front of his position and avoid selecting a target on his flank. The range operators of the detector sections located between two targets must exercise judgment as to which of the two targets to select, as otherwise, too many lights will be searching for one target and too few for the other. When the section is part of a large coordinated defense, the selection of the target is not made by the range operator. In this case, each detector is assigned a definite sector. When data concerning an approaching target are communicated to the plotting board of the regiment or higher command, the searchlight controller there will decide which detector will track the target.

c. After pick-up, the nearest two carry (rear) lights place their beams on the target and carry it. The pick-up (forward) lights go out of action (if no new target is located) or change target. If the mission is illumination for friendly fighter aviation, two, never more than three, lights will normally remain on target.

■ 42. **PLANNING.**—a. After an aerial night attack commences, only a very limited time will be available in which to issue orders. Therefore, to insure efficient cooperation between the

lights during an attack, the procedure to be followed must be worked out before the light sections proceed to their assigned positions. Initiation of action must be based on a few simple plans. Standing operating procedures are usually outlined by battalion or higher command in order to insure an efficient plan of action under the stress of attack. (See par. 47.)

b. After the various forms of enemy attack have been visualized, and suitable means of combating them have been devised, the light unit commanders and later the light units must be drilled over and over again until their response to a given situation is quick and without confusion.

c. The exact procedure to be adopted will depend on enemy tactics, the prevailing weather, the strength of the defense, and other factors of the moment. The provisions of the standing operating procedure outlined by the battalion or higher commander will prescribe proper action for the usual situation that may arise and will provide for the coordination of lights so that effective illumination may be secured.

■ 43. NOTES ON OPERATION.—If not otherwise specified in the standardized procedure set up by battalion or higher command, or otherwise restricted, the following notes on operation may be applied:

a. All pick-up (forward) lights within pick-up distance of the target will go into action when the target comes in range.

b. More than three lights will not be employed against a target, since too many lights conceal the target behind a screen of intense illumination.

c. After pick-up, two carry (rear) lights carry the target. All others go out of action, swing around to the front, and await the next target. When a target is passed to the carry lights, the pick-up light which has first illuminated the target is usually the first to go out of action.

d. The chief of section may direct the searchlight commander to assist in the illumination of a target by forming an intersection with the beam from the light in the adjoining light sector ("Light 2 search on light 3"). Meanwhile the detector tracks another target. As the new target approaches, and the light is ordered into action on it, the zero readers have only to center pointers in order to flick the new target.

If the new target is not yet within range, the light goes out of action until the target reaches the proper range.

e. If more than one target is approaching the platoon sector of a defended area, the forward or pick-up lights should not track any target within the forward line of lights, even if this target has not been picked up by this time. When the forward line of lights is reached, the beam should be returned to the front in order to illuminate a succeeding target. In a multiplane attack, it is usually possible to cause two beams to intersect on each of two targets. As soon as a target is picked up by a searchlight, the detector searches for a new target so that the beam may be placed immediately on the second target just as soon as first is passed to the carry lights. It is better to concentrate two lights on each target, disregarding the other airplanes until they can be illuminated.

f. Any pick-up light which is in range of the target and whose detector or distant electric control (D. E. C.) fails should search in the region being covered by the other pick-up lights of the platoon sector.

g. If the distant electric control fails, the extended hand controller should be immediately connected and used.

h. Where no communication between lights exists, lights always go into action on the initiative of the section chief. When one light starts a search, the other pick-up lights within range, unless restricted by higher headquarters, go into action immediately and assist.

■ 44. MOVING SITUATIONS.—a. Whenever the antiaircraft artillery defense is acting in a mobile situation, planning ahead and anticipating the next move are imperative.

b. When the antiaircraft artillery is part of the field forces in combat, it is necessary to have prepared plans for a forward and a retrograde movement. For a discussion of the disposition of searchlight units during such movements, and a description of the communication nets in a moving situation, see FM 4-105.

c. The tactical situation will usually be such that it will not be wise to have the light units take the road to a central bivouac. In this case, it will often be possible to attach the men of each light to the nearest artillery or infantry unit for rations, or to develop a plan of hot ration distribution

from platoon messes. However, lights usually remain in position, camouflaged (or withdrawn to concealed positions), and rations in hot food containers are supplied at light positions.

d. There is scarcely any type of military work that makes greater demands on the noncommissioned officer than the command of an antiaircraft searchlight unit, especially in a moving situation. He must understand something of radio, electricity, gasoline motor vehicles, power plants, map reading, messing, and supply. The only way the platoon commander can be sure that the necessary knowledge is acquired is to train the unit commanders and then try them out in simulated war situations.

■ 45. CARRYING THE TARGET.—When an illuminated target flies across a defended area, it must be passed from carry light to carry light, always keeping two lights on it, or never more than three if the mission of the searchlights is assistance to friendly fighter airplanes. This should be done without orders. In order that all concerned may know what is expected, this movement should be frequently practiced.

SECTION V

BATTERY AND BATTALION TRAINING

■ 46. PURPOSE OF TRAINING.—*a.* Battery and battalion training will give searchlight platoons and subordinate units practice in operating efficiently together for the purpose of coordination in the defense of an area. The battalion commander outlines a plan for the adequate illumination for the antiaircraft defense. This plan is closely coordinated with the mission of the gun defense and the activities of friendly fighter aviation employed in defending heavy and medium bombardment objectives. The battalion commander, in turn, informs the battery commanders of the plan for the defense and instructs them in the action of their units in accomplishing the mission assigned to the battalion by higher command.

b. For a discussion of the tactical disposition of searchlights in the defense of rear area objectives, and for the employment of searchlight units with the field forces, see FM 4-105.

■ 47. **STANDING OPERATING PROCEDURE.**—*a.* For effective operation, searchlights require a carefully prepared plan of action to be followed upon the approach of enemy aircraft. The battalion, or more often, higher command, may provide more efficient training for the engagement of hostile targets by the drafting of brief outlines of standing operating procedure which will serve as guides for the employment of individual lights in a coordinated defense of an assigned area. By the use of such standing operating procedures, chiefs of section and searchlight commanders may anticipate the tactical situations that will arise, and may prepare themselves for the split-second decisions which they must make in battle.

b. As local conditions and the tactical situation will vary in any given area, separate standing operating procedures must be developed for each region to cover the details of procedure peculiar to that region. Ordinarily, such outlines will include, among others, the following items of operation:

- (1) General plan for the assignment of sectors to searchlight platoons.
- (2) Hours during which units will operate.
- (3) Definition of the status of alert. Personnel required to man equipment during rest periods.
- (4) Searchlights to provide illumination for the defense as a whole.
- (5) Searchlights are auxiliaries to gun batteries. Their primary mission to illuminate for gunfire.
- (6) Maximum range of the guns in the area defense.
- (7) Relationship of number of searchlights to number of gun batteries.
- (8) When assisting friendly fighter aviation, caution to keep light off identified friendly airplanes.
- (9) Normal number of lights which will go into action on a prescribed course.
- (10) Time for the illumination of the target—the range for the first flick of target. Whether IN ACTION will be by higher command or by standing operating procedure.
- (11) Time for OUT OF ACTION. By higher command or by standing operating procedure.

(12) Minimum lights in action consistent with searching and target illumination.

(13) Conditions under which light will be directed to search in adjacent sector.

(14) Number of targets to be carried simultaneously.

(15) Caution to keep beam on target until next light has illuminated it, or it has passed beyond range.

(16) In case of the attachment of a separate gun battalion to the regiment and a consequent change in the plan of defense, decision as to whether more targets will be illuminated for a shorter time, or whether more batteries will engage each individual target for the same length of time as in the normal situation.

■ 48. BATTALION TRAINING EXERCISE.—A training problem which will afford profitable drill to the searchlight units of the battery and the battalion and which will give a practical test of the degree of teamwork developed in the battalion may be organized by the arrangement for several waves of target airplanes to approach a defended area at night and from various directions. For the radio and telephone communication nets, see FM 4-105. An improvised "operations board", with range arms pivoted about the plotted position of each light unit, is set up at the battalion headquarters. It is really a map of the defended area, and has plotted on it the location of each searchlight and searchlight detector. Each searchlight unit is oriented in azimuth referred to north. The telephone or radio operator at each detector-searchlight unit reports data as discussed in paragraph 41a. As this information is transmitted to the battalion command post, the azimuth and slant range of the target from each detector-searchlight unit is plotted on the battalion "operations board" by means of the pivoted range arms. By the intersection of the arms on the board, the approximate position of the target is determined, and a "searchlight controller" directs the lights in a platoon sector to go into action when the target is within range. This battalion training exercise also tests the degree of coordination accomplished by the units of the battalion, and the efficiency of operation of the standing operating procedure is observed.

CHAPTER 4

FUNCTIONING OF MATÉRIEL

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SECTION I

ANTIAIRCRAFT SEARCHLIGHTS M1941

■ 49. COMPARISON OF SPERRY AND GENERAL ELECTRIC SEARCHLIGHTS M1941.—A large number of the searchlight units in the field are equipped with either the Sperry or the General Electric searchlight, M1941. Both of these searchlights are manufactured under the same specifications and their basic operating principles are similar. The differences are in nomenclature and in the methods which each company has evolved to satisfy the specifications according to its own designs and manufacturing facilities.

■ 50. ANTIAIRCRAFT SEARCHLIGHTS M1941.—*a.* The source of illumination in the Sperry or the General Electric searchlight M1941 is a direct current, electric arc of 150 amperes at 78 volts, using high intensity carbons. The illumination from the arc is automatically maintained at the focal center of a 60-inch parabolic metal mirror with a total beam spread of $1\frac{1}{4}^{\circ}$ when the searchlight is in focus. The arc and mirror are protected by a drum. A ventilating fan mounted on top of the searchlight cools and sweeps the interior of the drum free of hot gases. The drum is so mounted as to permit continuous rotation in azimuth, and movement in elevation from approximately 200 mils depression to approximately 2,300 mils elevation. (See figs. 7 and 8.)

b. The lamp is a unit which hold the carbons. It is housed in the drum. The lamp control mechanism is contained in a box on the outside of the drum, just above the

right trunnion arm. The function of this mechanism is to operate the arc at maximum efficiency by feeding the carbons at a speed which will maintain them in their proper relative positions. The lamp and lamp control mechanism accomplish two important functions—an optical function and an electrical function.

c. The *optical function* is to keep the globule of incandescent gas, which is formed in the crater of the positive carbon, at the focal point of the mirror. This is accomplished by an automatic thermostat-operated, electro-mechanical feed system which causes the positive carbon to feed forward as fast as it burns back.

d. The *electrical function* of the lamp and lamp control mechanism is to maintain a constant arc length (the distance from the negative carbon tip to the positive carbon crater) by feeding the negative carbon forward as it burns back.

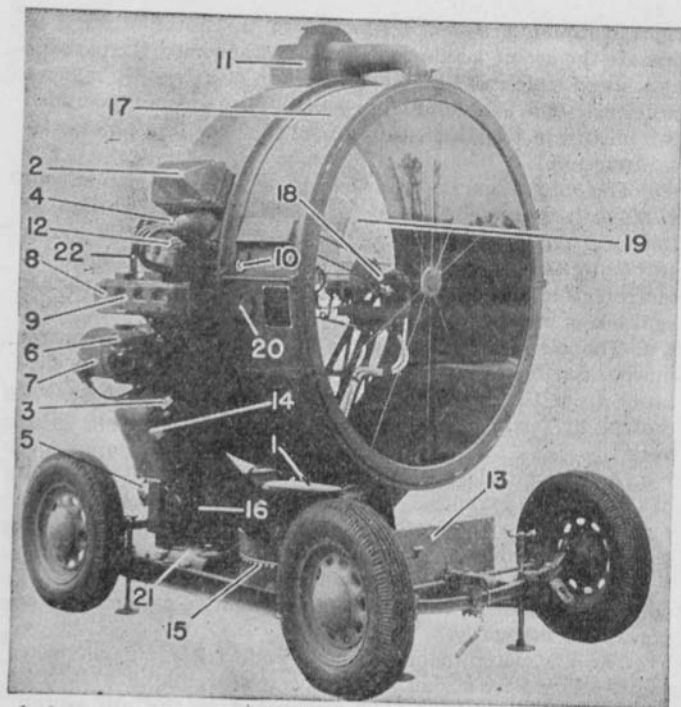
e. A "ground glass finder" indicates visually the position of the positive carbon.

f. Blue glass arc view "peep sights" are mounted on either side of the drum for observing the arc.

g. In case of failure of the automatic features of the lamp control mechanism, the positive and negative carbons can be controlled manually.

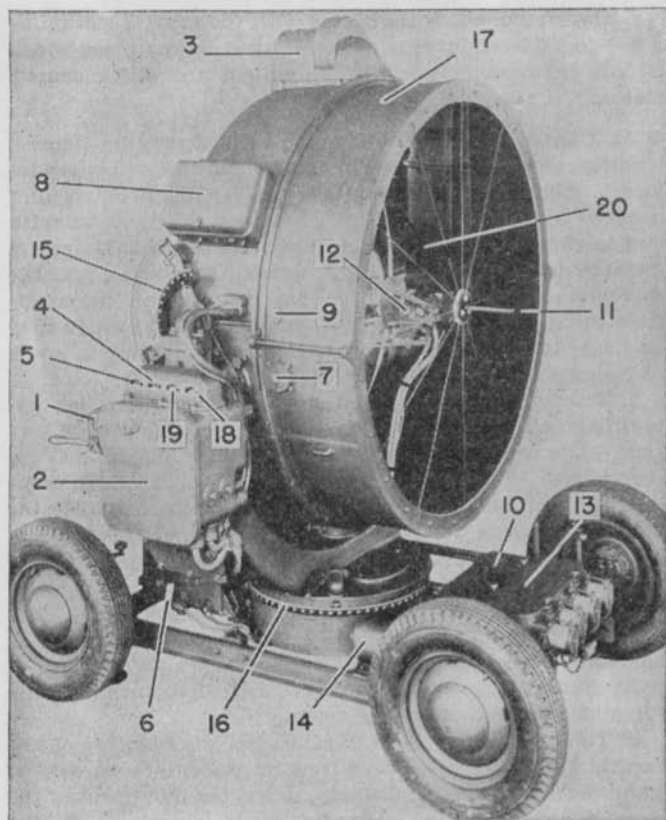
h. An arc switch mounted on the right trunnion arm opens and closes the arc circuit. The Sperry searchlight M1941 has an additional mechanism, incorporated in the arc switch, which provides for an instantaneous arc strike. This mechanism is a thermal operated, time delay, circuit breaker.

i. The searchlight is moved in azimuth and elevation by means of distant electric control (D. E. C.) from the control station. The light may also be moved manually in azimuth and in elevation by use of an extended hand controller.



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|-----------------------------------|----------------------------|
| 1. Azimuth data receiver housing. | 11. Ventilating motor. |
| 2. Lamp control mechanism box. | 12. Elevation scale. |
| 3. Recarboning safety switch. | 13. Ballast resistor. |
| 4. Recarboning lamp switch. | 14. Arc switch box. |
| 5. Power cable receptacle. | 15. Azimuth scale. |
| 6. Hand controller socket. | 16. Junction box. |
| 7. Elevation control motor. | 17. Front drum. |
| 8. Elevation zero reader. | 18. Lamp unit. |
| 9. Azimuth zero reader. | 19. Mirror. |
| 10. Arc view peep sight. | 20. Ground glass finder. |
| | 21. Dynamotor. |
| | 22. Elevation gear sector. |

FIGURE 7.—Sperry searchlight M1941—front quarter view.



- | | |
|--------------------------------------|----------------------|
| 1. Extended hand control bar socket. | 11. Positive carbon. |
| 2. Arc and elevation control box. | 12. Lamp unit. |
| 3. Ventilating fan motor. | 13. Junction box. |
| 4. Elevation zero reader. | 14. Dynamotor. |
| 5. Azimuth zero reader. | 15. Elevation scale. |
| 6. Azimuth control box. | 16. Azimuth scale. |
| 7. Ground glass finder. | 17. Front drum. |
| 8. Lamp control box. | 18. Ammeter. |
| 9. Peep sight glass. | 19. Voltmeter. |
| 10. Ballast resistor. | 20. Mirror. |

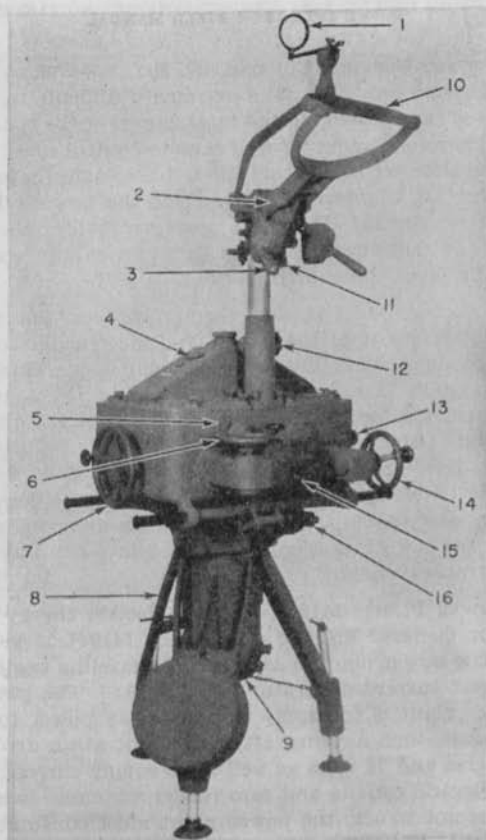
FIGURE 8.—General Electric searchlight M1941—front quarter view.

j. The searchlight is connected with the control station by a 500-foot 15-conductor cable, identified by red plugs which fit into red receptacles at the searchlight and at the control station.

■ 51. CONTROL STATIONS M1941.—*a.* The Sperry or General Electric control station consists of a control unit and binocular mount mounted on a tripod (see fig. 9). The control unit provides for the remote control of the searchlight in azimuth and in elevation. Remote control of the searchlight from a distance improves the contrast between the target and the surrounding illuminated field. The control unit also controls the movement of the observer's binoculars, which may be made to search the area about a moving point in space as established by the detector data.

b. Two zero reading voltmeters (zero readers), one for azimuth and one for elevation, are mounted on the control station. There are also two zero readers mounted on the searchlight. When the searchlight and the detector are properly oriented and synchronized, the zero readers indicate the relative positions of the searchlight and the detector, and are centered when the light and the detector are pointing in the same direction. Thus the zero readers are part of the data transmission system, and as the directional data from the detector changes, the zero readers indicate to the control station operators the direction in which the searchlight should be moved in order to keep it pointing in the direction determined by the detector.

c. The azimuth and elevation control mechanisms of the control unit may each be driven by either of two sets of handwheels. These handwheels control the movement of the azimuth and elevation distant electric control (D. E. C.) transmitters which operate the azimuth and elevation D. E. C. receivers (training motors) on the searchlight. The handwheels also operate the binocular mount to move the binoculars in elevation. The binocular mount turns in azimuth with the control unit.



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|--|--|
| 1. Open sight. | 9. Fifteen point receptacle. |
| 2. Binocular elevation zero marker. | 10. Binocular mount. |
| 3. Binocular mount adjustment handles. | 11. Binocular azimuth zero marker. |
| 4. Azimuth "zero reader." | 12. Binocular height adjusting knob. |
| 5. Signal buzzer push button. | 13. Elevation "zero reader" handwheel. |
| 6. Observer's azimuth handwheel. | 14. Observer's elevation handwheel. |
| 7. Azimuth "zero reader" handwheel. | 15. "Zero reader" light switch. |
| 8. Tripod. | 16. D-C switch. |

FIGURE 9.—Sperry control station M1941.

■ 52. DISTANT ELECTRIC CONTROL (D. E. C.).—Due to the absence of visual contrast, it is extremely difficult to see the illuminated target through the total length of the searchlight beam. Therefore, some form of remote control must be used to get the observer away from the light, so as to improve the visual contrast between the target and the beam. The distant electric control (D. E. C.) system provides the means whereby the movement of the searchlight can be controlled electrically from the control station.

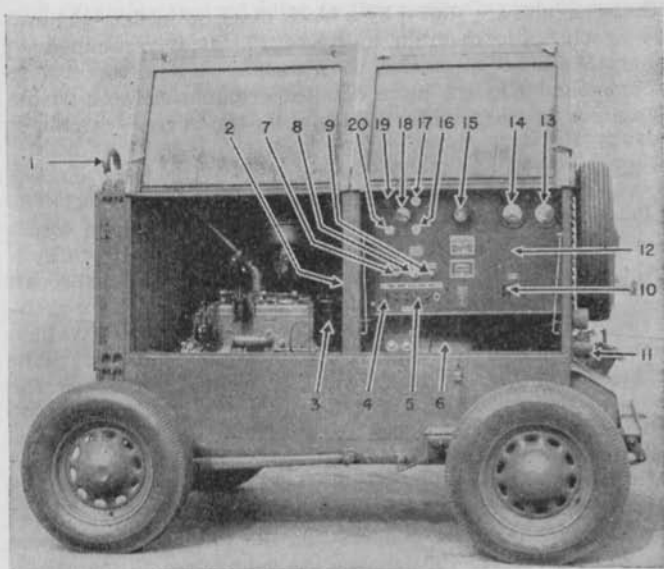
■ 53. DETECTOR.—*a.* The detector determines the azimuth and angular height of the target and electrically transmits these directional data over a self-synchronous data transmission system (synchronous repeaters) to the searchlight and control station. By this method the searchlight can be directed at the target.

b. The detector is connected to the searchlight by a 250-foot cable (cable No. 27 of the detector section) joined to a 10-foot adapter cable (cable No. 28 of the detector section). The plug of the adapter cable is fitted into the blue receptacle at the searchlight.

■ 54. POWER PLANTS M1941.—*a.* The electric energy for the Sperry or General Electric searchlight M1941 is generated by a mobile power plant consisting of a gasoline engine driving a direct current generator (see fig. 10). The purpose of the power plant is to supply the necessary power for operation of a 60-inch antiaircraft searchlight at an arc load of 150 amperes and 78 volts as well as to supply current for the distant electric control and zero reader systems. Even when the arc is not struck, the power plant must continue to operate so that current may be supplied for these two systems.

b. A dynamotor located on the searchlight chassis converts approximately 3 amperes of the direct current to alternating current for the operation of synchronous repeaters of the data transmission system (zero reader system).

c. The power plant is connected to the searchlight by two 200-foot single-conductor cables, one positive and one negative. The cables are identified by yellow plugs which fit into yellow receptacles at the searchlight and at the power plant.



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|-------------------------|--|
| 1. Tow bar. | 12. Control panel. |
| 2. Fan. | 13. Power ammeter. |
| 3. Oil filter. | 14. Power voltmeter. |
| 4. 115-volt receptacle. | 15. Voltage regulating rheostat. |
| 5. Ignition switch. | 16. Temperature gage. |
| 6. Power generator. | 17. Charging ammeter. |
| 7. Choke control. | 18. Tachometer and revolution counter. |
| 8. Starter button. | 19. Gasoline gage. |
| 9. Throttle control. | 20. Oil pressure gage. |
| 10. Main switch. | |
| 11. Power receptacles. | |

FIGURE 10.—Sperry power plant M1941.

SECTION II

SPERRY SEARCHLIGHT M1941

■ 55. PRINCIPAL ELECTRIC CIRCUITS.—Sperry searchlight equipment is operated by three principal electric circuits:

The arc circuit.

The distant electric control circuits.

The zero reader circuits.

These circuits are shown by a block diagram in figure 11 and by a schematic diagram in figure 12. It is recommended that this brief discussion of principal electric circuits be supplemented by the more detailed explanations and wiring diagrams in the Operator's Manual for the Sperry searchlight M1941.

a. Arc circuit.—(1) The arc circuit is the basic electric circuit for the operation of the searchlight equipment. The source of power for all the principal circuits is the direct current, electric energy supplied by a generator driven by a gasoline engine. The electric energy is transmitted through two power plant cables to the junction box on the searchlight. The current passes through a "ballast resistor", which can be adjusted for different lengths of the power plant cables. The current then passes through slip rings at the base of the searchlight and finally to the lamp unit inside the searchlight drum. The arc circuit requires 150 amperes while the other circuits require 12 amperes. The voltage at the power plant is approximately 105 volts when there is no arc load and when the power plant is running at rated speed. When the arc is operating, the voltage at the power plant drops to 100 volts due to the voltage regulation of the generator, and to 78 volts at the searchlight due to the voltage drop in the arc circuit between the power plant and the light.

(2) The lamp unit holds and feeds the positive and negative carbons and is actuated by a lamp control mechanism (see also par. 50b and fig. 7). The lamp control mechanism performs the optical function and the electrical function, as explained in paragraph 50c and d. The electrical function is based on the electrical principle that the arc voltage varies directly with the arc length. This function is accomplished automatically by positioning the negative carbon by means of an "arc length control coil" and a double ratchet and pawl assembly in the lamp control mechanism.

b. Distant electric control (D. E. C.) circuits.—(1) The distant electric control circuits consist of distant electric control (D. E. C.) transmitters located in the control station which actuate distant electric control (D. E. C.) receivers at the searchlight. There is one complete D. E. C. system for azimuth and one for elevation. The terms "D. E. C. receiver"

and "training motor" refer to the same element of searchlight equipment. This system operates on direct current. The handwheels on the control station are geared to the rotors of the D. E. C. transmitters. One rotation of the observer's handwheel turns the transmitter rotor two revolutions. This rotation is transmitted electrically through the control station cable (500 feet) to the junction box on the searchlight, then to the D. E. C. receiver. Sufficient torque is developed in the rotor of the D. E. C. receiver to turn the light through a gear ratio of 150 to 1. The rotor of the D. E. C. receiver has four electromagnetic poles of constant polarity connected in series with the field windings through the D. E. C. transmitter. The D. E. C. transmitter is a rotary switch with a three-pole rotor and a four-contact stator with insulating segments between contacts. Rotating this transmitter changes the magnetic polarity of the 12 field coils in sequence in the D. E. C. receiver. When the D. E. C. transmitter is turned 150 revolutions the light will make one complete revolution in steps of $\frac{1}{10}^{\circ}$. These steps may be noticeable when turning the control station handwheel slowly. However, they do not cause irregularity of movement while tracking, because the beam is wide at normal tracking distances, and the inertia of the moving parts smoothes out the effect of these steps.

(2) The azimuth handwheel on the control station, in addition to turning the azimuth D. E. C. transmitter rotor, also turns the control unit in azimuth. The elevation handwheel, in addition to turning the elevation D. E. C. transmitter rotor, also operates the binocular mount in elevation to move the binoculars.

c. Zero reader circuits.—(1) The zero reader circuits consist of two identical, independent electrical circuits, one for azimuth and one for elevation. These circuits are electrically separate from each other and from the D. E. C. circuits. The zero reader circuits consist of data transmitters (a-c synchronous repeaters) on the detector which electrically transmit angular positions in azimuth and in angular height of the target through the detector cable to the data receiver (a-c synchronous repeaters) on the searchlight. Here the electrical data are electromechanically compared with the

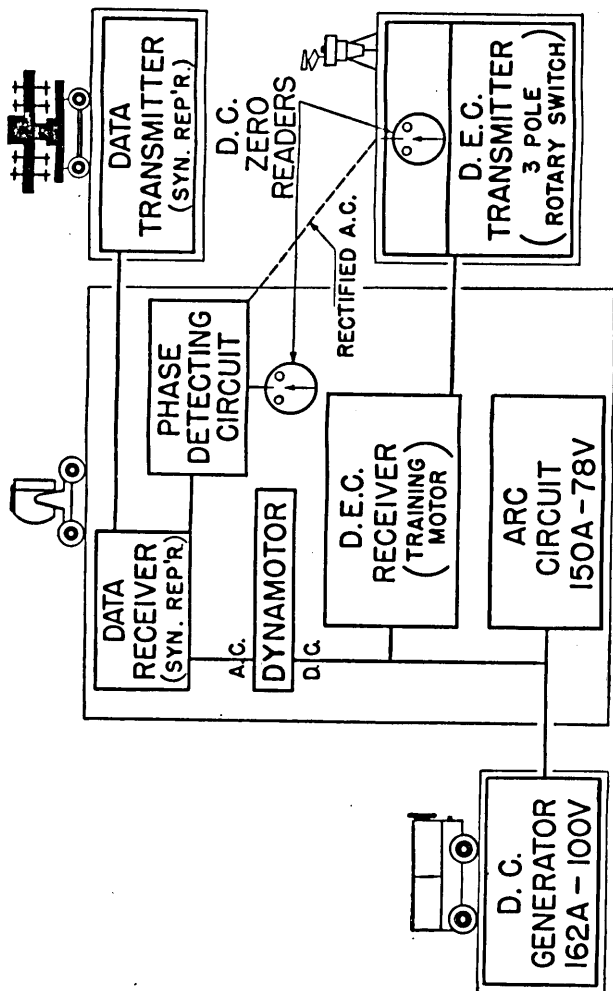


FIGURE 11.—Principal electric circuits, Sperry M1941—block diagram.

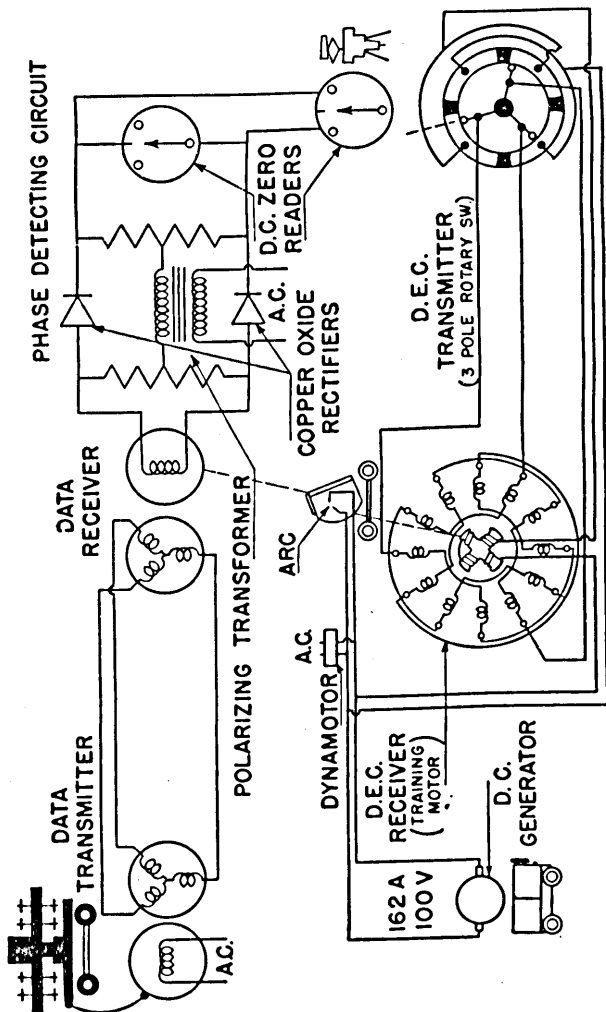


FIGURE 12.—Principal electric circuits, Sperry M1941—schematic diagram.

angular positions of the searchlight, and are visually indicated on two sets of zero reading voltmeters, electrically connected in parallel, two on the searchlight, and two on the control station.

(2) Each data transmitter rotor is connected across the a-c output of the dynamotor. By transformer action, a magnetic field is set up in the stator windings of the data transmitter. The angular position of this field is transmitted electrically through the detector cable to the searchlight, and is reproduced in the stator windings of the data receiver on the searchlight. When the detector is tracking a target, it causes the rotor of the data transmitter to rotate, and this in turn causes the magnetic field in the stator of the data receiver to rotate correspondingly. The rotor of the data receiver is mechanically geared to the gearing (azimuth or elevation) of the searchlight.

(3) When the searchlight and the detector are pointing in the same direction (assuming that the units are properly oriented and synchronized), the voltage induced in the data receiver rotor will be zero. The needles of the zero readers at the searchlight and at the control station will be centered. If the searchlight is not pointing in the direction as indicated by the detector, then there will be a voltage induced in the rotor of the data receiver which will cause the needles of the zero readers at the searchlight and control station to deflect, indicating visually to the operator at the control station that the searchlight is not following the detector. The searchlight must then be turned in the direction indicated to center the needles (either manually or by means of D. E. C.) so as to cause the searchlight to keep up with the detector, thereby causing the needles of the zero readers to be continuously centered.

(4) The Sperry zero reader system operates on the a-c output of the dynamotor and uses direct current voltmeters as zero voltage indicators. Therefore, some rectifiers must be used to convert direct current into alternating current. These rectifiers are in the "phase detecting circuit" consisting of two copper oxide rectifiers, two center tap resistors, and a polarizing transformer with two 10-volt secondaries. One secondary is used for azimuth and one for elevation, as

22 e-1
there is a complete and independent zero reader system for azimuth and one for elevation. The phase detecting circuit compares electrically the polarity of the voltage of the a-c source (dynamotor) and the polarity of the voltage induced in the rotor of the data receiver rotor. The comparison is visually indicated on the zero readers and indicates the direction in which the searchlight must be moved in order that it may point in the same direction as the detector.

d. Reference.—For a complete description and a detailed explanation of the operation and maintenance of the Sperry searchlight M1941 see the Operator's Manual for this light.

SECTION III

GENERAL ELECTRIC SEARCHLIGHT M1941

■ 56. COMPARISON OF GENERAL ELECTRIC AND SPERRY SEARCHLIGHTS M1941.—*a.* In general, the basic operating principles of the General Electric searchlight equipment M1941 are similar to those of the Sperry searchlight M1941 covered in section II of this chapter. Certain differences in nomenclature between the two searchlights may be observed. Each company, while meeting the same general requirements, has devised methods which are best adapted to its own manufacturing facilities.

b. The following chart tabulates the main features of the two searchlights:

ANTIAIRCRAFT SEARCHLIGHTS—SPERRY M1941 AND GENERAL ELECTRIC M1941

Sperry M1941

General electric M1941

I. POWER PLANT

- | | |
|-----------------------|--|
| A. Motive power | Six cylinder "Hercules JXD" gasoline engine |
| B. Governor | Centrifugal (Pierce) single speed setting |
| C. Speed | 1,100 rpm |
| D. Radiator position | At front end of power plant |
| E. Radiator fan | Electric motor driven |
| F. Generator | D-c |
| 1. Current (arc load) | 162 kw |
| 2. Voltage (arc load) | 162 amps |
| G. Power plant cables | 100 volts |
| | Two single conductor power plant cables one positive (+) and one negative (-) each 200 feet long. Transmit the d-c power to the searchlight. |

1,200 rpm
Engine, belt driven
16 kw
160 amps
100 volts

II. ARC CIRCUIT

- | | |
|---------------------------|--|
| A. Source of illumination | The direct current of 150 amperes and 78 volts flowing through the high intensity carbons creates an extremely hot arc and forms a crater in the tip of the positive carbon, containing a highly incandescent globule of gas, which is the source of illumination. |
| B. Positive carbon | 22" long x .633" O. D. (16 mm) |
| C. Negative carbon | 12" long x .434" O. D. (11 mm) |
| D. Burning time | 1½ hours approx. |
| E. Arc current | 150 amps., d-c |
| F. Arc voltage | 78 volts, d-c |

III. LAMP CONTROL MECHANISM

A. Automatic control motive power

1. Positive carbon

a. optical function

Maintain the light source of the positive carbon at the focal center of the mirror by means of the thermostat control.

b. operation

Rotates continuously, feeds forward when

"ratchet gear" "detent wheel"

is held stationary by

"feed plunger" "detent"

which in turn is actuated by

"positive feed electromagnet" "positive feed magnet"

which in turn is energized by "thermostat contacts"

or

"roller arm contacts." "semiautomatic feed contacts."

The "roller arm contacts" are set for approximately one-half the rate of burning. The semiautomatic feed contacts are set at "minimum."

ANTI-AIRCRAFT SEARCHLIGHTS—Continued

2. Negative carbon

a. electrical function

Sperry M1941

Uses *voltage* control.

Arc voltage varies directly as the arc length.

b. operation

"Arc length control coil" is connected in parallel with the arc, and the electromagnetic force in the coil, which is proportional to the arc voltage, pulls an "armature" in opposition to an "adjustment spring." This action positions the "negative pawl guards," which in turn control the forward or backward movement of the negative carbon to maintain a constant arc voltage.

General electric M1941

Uses *current* control.

Arc current varies inversely as the arc length.

"Current regulator coil" is connected in series with the arc, and the electromagnetic force in the coil, which is proportional to the arc current pulls an armature in opposition to an "adjustment spring." This action positions the "current regulator contacts" which in turn energizes the "feed coil" or "retract coil" of the "negative drive clutch." The negative carbon is thus moved forward or backward to maintain a constant arc current.

B. Semiautomatic control

If thermostat should fail, adjust

"Roller arm contacts" by turning "Positive feed rate contacts" by "positive feed rate adjustment" turning the "positive feed rate

screw" $1\frac{1}{4}$ turns counterclockwise toward its maximum feed position. If above setting does not give correct rate, adjust to keep the positive carbon tip on the focal line of the "ground glass finder."

C. Manual control

1. Positive carbon

Used in event of failure of the automatic control.

Rotate positive carbon by rotating "positive hand feed pushing "in" and rotating "positive drive crank." handwheel."

Feed positive carbon forward and maintain the tip on the focal line of the "ground glass finder," by: pushing "positive hand feed lever" to "hand" position while the positive carbon is being rotated. *Care should be taken not to overfeed the positive carbon as it cannot be retracted.*

2. Negative carbon

Maintain the arc voltage of 78 volts as read on the arc voltmeter, by first pushing the "negative feed centralizer" lever to "hand" position and then turning the "negative hand feed knob" in the proper direction. Maintain the arc current of 150 amperes as read on the arc ammeter by pushing in and turning the "negative drive crank" in the proper direction.

ANTI-AIRCRAFT SEARCHLIGHTS—Continued

IV. DYNAMOTOR

(on the searchlight)

Sperry M1941

General electric M1941

Converts d-c to a-c used by all a-c synchronous repeaters (Selsyns) of the searchlight equipment.

Also furnishes a-c for the "polarizing transformer" in the phase detecting circuit. Also furnishes a-c for the stator coils of the a-c zero reading voltmeters.

V. DISTANT ELECTRIC CONTROL (D. E. C.)

A. Function

Provides a remote control of the searchlight in azimuth and elevation.

B. Operation

"D-c three-pole rotary switches" "A-c synchronous repeaters (Selsyns)"

1. D. E. C. transmitters (control station)

located inside the control unit and are actuated by the control station handwheels. Electrically connected through control station cable (500' long) to:

2. D. E. C. receivers (searchlight)

"Step by step d-c training motors" "A-c synchronous repeaters (Selsyns) each of which *mechanically* actuates a contact plate in a "d-c bridge controller" circuit which in turn electrically controls a d-c training motor, geared to the searchlight. The training motor in addition to

turning the light, is geared back to the stator of the D. E. C. receiver so that the stator is rotated mechanically the same amount as the magnetic field of the rotor. This differential action causes the contact plate to be centered.

D. E. C. receiver and training motor are the same unit

A "d-c" switch located at the bottom of the control unit. A "D. E. C." switch located on the observer's side of the control unit.

Purpose—to turn the D. E. C. system "ON" or "OFF."

Indicates the relative positions of the detector and searchlight in azimuth and elevation.

Two synchronous repeaters (Selsyns) are located inside the detector, one for azimuth and one for elevation, and their rotors are geared to azimuth and elevation gearing of the detector, respectively. A detector cable (maximum length 260') transmits the angular positions electrically to:

3. Training motors

C. D. E. C. switch (control station)

VI. ZERO READER SYSTEM

A. Function

B. Operation

1. Data transmitter (detector)

ANTIAIRCRAFT SEARCHLIGHTS—Continued

2. Data receivers (searchlight)

Sperry M1941

General electric M1941

Two synchronous repeaters (Selsyns) located on the searchlight, one for azimuth and one for elevation and their rotors are geared to azimuth and elevation gearing of the searchlight, respectively. Data receiver rotor a-c voltages Data receiver rotor a-c voltages are transmitted to the "phase detecting circuit." "Rectified a-c" voltages from the "phase detecting circuit" are transmitted to:

two d-c zero readers.

two a-c zero-center dynamometer type voltmeters.

3. Zero reading voltmeter (searchlight and control station)

One voltmeter is located on the searchlight to facilitate synchronization and to allow searchlight to be manually trained with the "extended hand controller" on detector data, in case of failure of the D. E. C. The other voltmeter is located on the control station to allow the "zero reader operator" to train the searchlight in accordance with detector data by means of the D. E. C. There is one set of two voltmeters for azimuth, and another set of two voltmeters for elevation.

■ 57. PRINCIPAL ELECTRIC CIRCUITS, GENERAL ELECTRIC M1941.—General Electric searchlight equipment is operated by three principal electric circuits:

The arc circuit.

The distant electric control circuits.

The zero reader circuits.

These circuits are shown by a block diagram in figure 13 and by a schematic diagram in figure 14. It is recommended that this brief discussion of principal electric circuits be supplemented by the more detailed explanations and wiring diagrams in the Operator's Manual for the General Electric searchlight M1941.

a. Arc circuit.—The basic principles of the operation of the arc circuit in the General Electric are exactly the same as those of the Sperry discussed in section II of this chapter. However, the electrical function (constant arc length) is accomplished by a different method in the General Electric, and is based on the electrical principle that the arc current varies inversely with the arc length. In this light, a current regulator coil actuates a negative drive clutch assembly in order to maintain a constant arc length. (See par. 56b, for comparison of this feature.)

b. Distant electric control circuits (D. E. C.).—The distant electric control (D. E. C.) circuits of the General Electric include two complete D. E. C. systems for both azimuth and for elevation. Each circuit consists of a D. E. C. transmitter (synchronous repeater or Selsyn) located at the control station which actuates a D. E. C. receiver (synchronous repeater or Selsyn) at the searchlight. The rotor of the D. E. C. receiver mechanically actuates the contact plate of the d-c bridge controller circuit which in turn electrically controls the speed of rotation of a d-c training motor geared to the searchlight. The training motor, in addition to turning the light, is geared back to the stator of the D. E. C. receiver so that the stator is rotated mechanically the same amount as the magnetic field of the rotor. This differential action causes the contact plate to be centered. The bridge controller and the training motor operate on direct current.

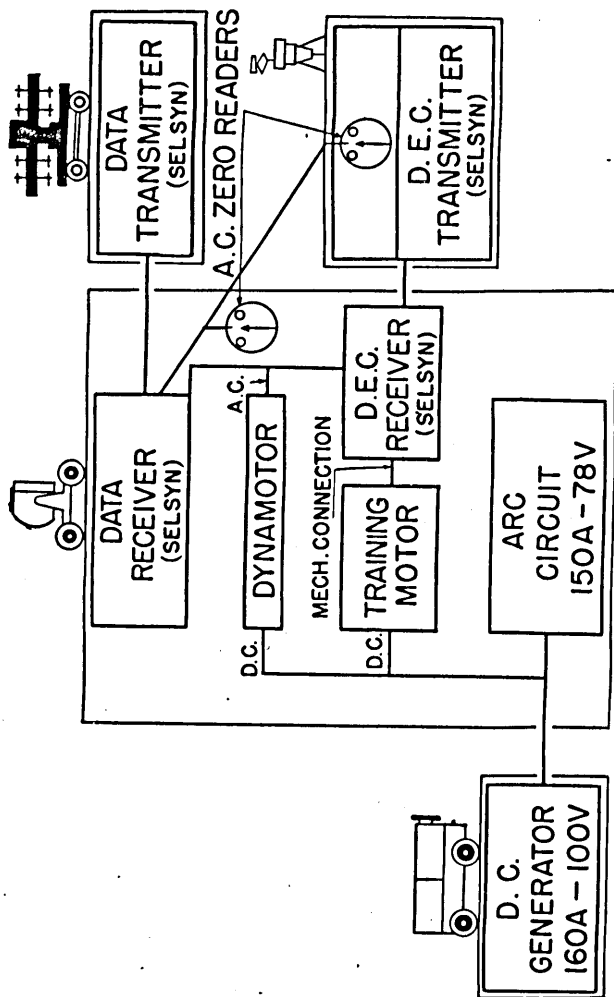
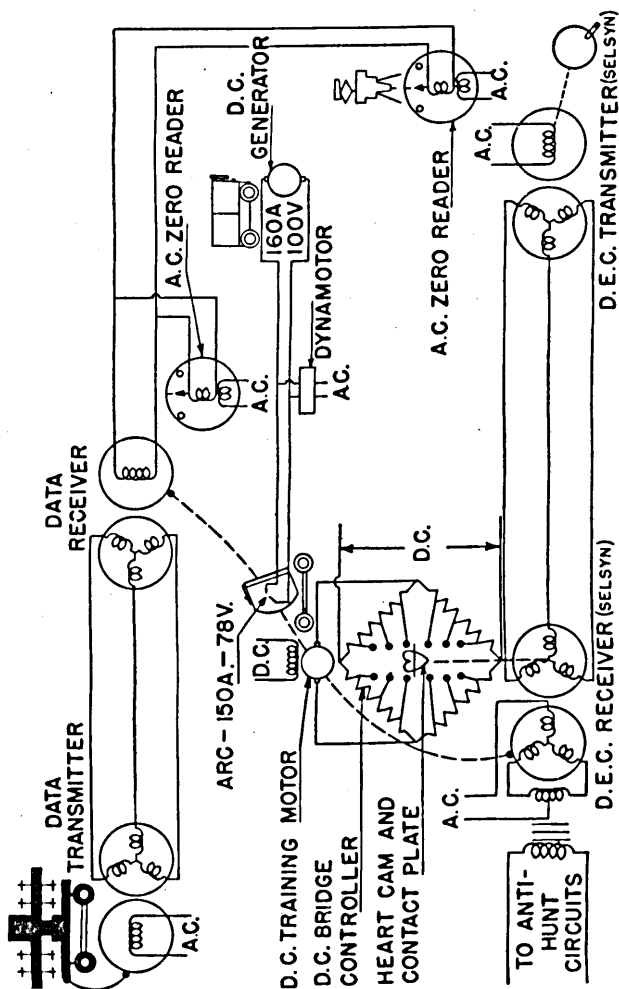


FIGURE 13.—Principal electric circuits, General Electric M1941—block diagram.



c. Zero reader circuits.—The zero reader circuits of the General Electric are fundamentally similar to those of the Sperry as discussed in paragraph 55*d*. (See also par. 56*b* for comparison of the zero reader circuits of the two searchlights.) The operation of the zero reader circuits of the two searchlights is essentially alike; the only difference is in the methods used to accomplish the same results. The most important difference is that, in the General Electric zero reader circuits, the data receiver rotor a-c voltages are transmitted to two a-c zero center, dynamometer type voltmeters (zero readers). Thus the necessity for a phase detecting circuit, as used in the Sperry circuits, is eliminated.

d. Antihunt circuits.—As the General Electric D. E. C. system uses a-c Selsyn units the searchlight has a tendency to "hunt", that is, the searchlight swings back and forth through the point of alinement without coming to rest. The antihunt circuits are provided to dampen and eliminate this hunting tendency.

e. Reference.—For a complete description and a detailed explanation of the operation and maintenance of the General Electric searchlight M1941, see the Operator's Manual for this light.

SECTION IV

ANTIAIRCRAFT SEARCHLIGHTS M1941A AND M1942

■ 58. SPERRY SEARCHLIGHT EQUIPMENT M1941A.—*a.* In all important aspects the Sperry 1941A searchlight equipment is similar to that of the 1941 model. Only minor improvements have been incorporated in the later model. The Sperry power plant M1941A has two rear blackout lights and is better adapted for towing over rough terrain, as shock absorbers have been added and a heavy sheet iron skid bolted under the rear axle.

b. For a complete description and detailed explanation of the operation of this equipment, see the Operator's Manual M1941A.

■ 59. GENERAL ELECTRIC SEARCHLIGHT EQUIPMENT M1941A AND M1942.—*a. General Electric M1941A.*—Production of the General Electric M1941A has been limited. It is similar in all

major aspects to the General Electric M1941. In comparing the two models certain differences may be observed, among which the following are particularly notable:

(1) *Lamp head.*—The positive feed system is unchanged, and the negative feed system is exactly the same except that the 1941A uses a center, floating armature for connecting onto the common line which closes contact for energizing either feed or retract coil. This allows one contact point for feeding and two for retracting.

(2) *Data system.*—The data system, in itself, is unchanged. There is, however, in the a-c side of the data system a four-point manually operated gang switch that should be thrown when an external source of a-c power is employed.

(3) *D. E. C. system.*—The essential features of the electrical and mechanical system on the M1941 are unchanged. In order that the detector and the searchlight may be oriented and synchronized, a method of synchronization has been provided in the form of a mechanical differential tied into the driving shaft for turning the D. E. C. receiver stator. Synchronizing may be done by turning the synchronizing knob on the outside of the azimuth control box.

(4) *Power plant.*—The General Electric M1941A power plant is, in general, similar to the 1941 model. However, certain minor improvements have been built into the later model. Among these are two rear blackout lights, shock absorbers, and heavy sheet iron skids under front and rear axles. The shock absorbers and skids better adapt the power plant for towing over rough terrain.

b. *General Electric M1942.*—(1) *Comparison with earlier models.*—The only fundamental difference between the Sperry and General Electric searchlights M1942 and earlier models is the *method of distant electric control* (see (3) below). The Sperry and General Electric feed and arc mechanisms are virtually unchanged from the respective 1941 models, and the power plants of the two lights are essentially identical with the respective 1941 models.

(2) *General features, M1942.*—(a) The Sperry and General Electric searchlights M1942 (see fig. 15) are manufactured under the same specifications. Throughout the distant electric control systems identical parts are employed—amplidyne

generators, servo amplifier units, control motors, dynamotors and relays.

(b) Each of these searchlights may be positioned directly by a detector (or locator), without the action of controllers turning handwheels at the control station. After the detector (or locator) and searchlight have been oriented and electrically synchronized, the detector (or locator) may be moved to any position in azimuth or elevation and the searchlight will follow directly.

(c) The searchlight may also be positioned from the control station, either by controllers turning handwheels to center the needles of zero readers or by the light commander, using binoculars, turning the observer's handwheels.

(d) Transfer of control from the detector (or locator) to the control station may be accomplished at any time by closing a switch located on the control station. The searchlight will automatically position itself in a synchronous position with reference to the control station. If the switch is opened, control will return to the detector (or locator) and the searchlight will automatically position itself in a synchronous position with reference to the detector (or locator). This transfer of control is automatically synchronous and involves no loss of orientation.

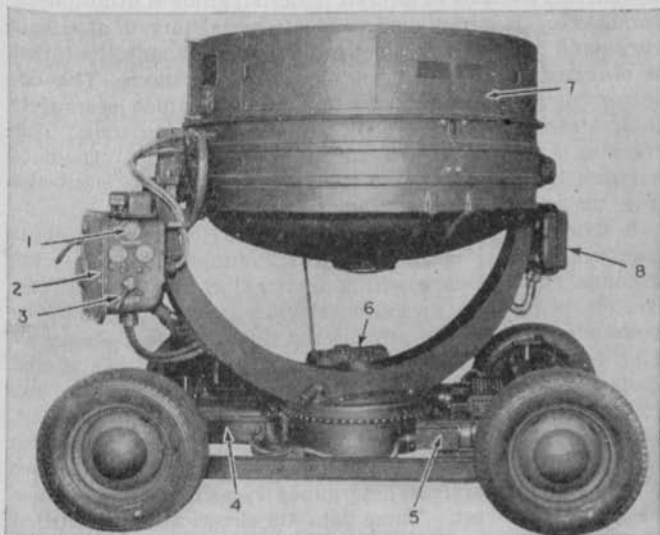
(e) Zero readers located on the control station indicate at all times the relative positions of control station and detector (or locator).

(f) Zero readers located on the searchlight indicate at all times the relative positions of searchlight and the controlling unit—detector, locator, or control station.

(3) *Distant electric control M1942.*—(a) Power motors on the searchlight are controlled by signals transmitted from synchronous repeaters (Selsyns) at the detector, locator, or control station to synchronous repeaters (Selsyns) located on the searchlight. The received signal is first rectified and amplified by a circuit employing power amplifier tubes. The resulting current energizes the control field windings of an amplidyne generator. The size and direction of the current in the control field windings determine the magnitude and polarity of the current output of the amplidyne. The amplidyne output operates a d-c power motor.

(b) The amplidyne generator and the power motor may be controlled by a d-c power switch.

(c) A protective circuit prevents operation of the distant electric control when either of the access doors to the drum is open.



- | | |
|--|------------------------------------|
| 1. Motor amplidyne generator set and power-motor feed switch (d-c power switch). | 4. Azimuth control box. |
| 2. Elevation control box. | 5. Elevation amplidyne. |
| 3. Arc switch. | 6. Azimuth amplidyne. |
| | 7. Steel drum. |
| | 8. Elevation servo amplifier unit. |

FIGURE 15.—General Electric searchlight M1942—showing amplidyne generators.

(d) Identical systems are used for azimuth and elevation distant electric control.

(e) The 1942 models have the advantage of higher speeds of traversing. Either light may be traversed at a rate between 35° and 40° per second. This feature will permit much greater flexibility of operation when functioning against the higher speeds of present targets.

SECTION V

POSITION FINDING EQUIPMENT

■ 60. DETECTOR.—*a.* A detector is one of the more recent and more effective devices which have been developed for the detection and tracking of aircraft under all kinds of atmospheric conditions. It is designed to locate aerial targets at a long range and its efficiency is not reduced even though the target is obscured by smoke, haze, clouds, or darkness. The detector supplies a continuous flow of data which accurately locates aircraft with reference to the detecting unit. This tracking is accomplished by means of a radio echo. The data supplied by the detector to the searchlight are azimuth and angular height.

b. One of the detector units now in use with searchlights locates aircraft by means of the functioning of three separate antenna systems, each with directional characteristics. By the operation of a mechanical system, the arrays may be pointed as one unit in any desired direction, and a beam of high frequency energy from one of the antennas is radiated in this direction. Any target in the field of the beam will reflect or reradiate a portion of the energy back to the unit. Here the reflected signal or echo is received by the remaining two direction finding antenna arrays. Operation of the two direction finding systems determines the azimuth and angular height of the target. These data are electrically transmitted to the searchlight by means of a self-synchronous transmission system (a-c synchronous repeaters).

c. For a detailed description of a detector and technical explanation of its operation, see FM 4-145.

■ 61. SOUND LOCATOR M2.—Certain organizations in the field may use the sound locator M2 as the equipment for locating the position of the target and for directing the searchlight at the target. For a detailed discussion of the theory of sound location and an explanation of the operation of the sound locator see FM 4-111, TM 9-1660, and 9-2660.

SECTION VI

VEHICLES

■ 62. GENERAL.—*a.* Transportation for the equipment of the detector-searchlight section consists of the vehicles of the detector section and those of the searchlight squad, respectively.

b. Transportation of the detector section is included in FM 4-145.

c. Searchlight equipment is transported by two standard 2½-ton trucks, one towing an M1 antiaircraft searchlight

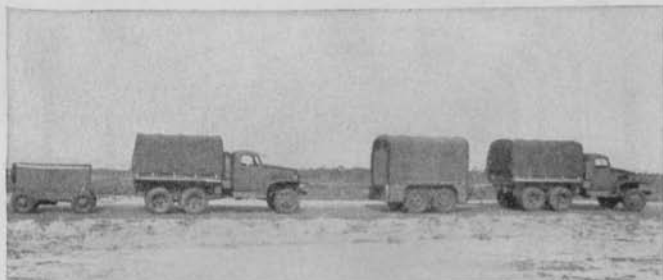


FIGURE 16.—Transportation of searchlight squad showing two 2½-ton trucks, M1 trailer, and searchlight power plant.

trailer in which is loaded the searchlight, and the other towing the power plant (see fig. 16). Each of the trucks has a cargo body of 80 inches by 108 inches and is equipped with hold-down devices or bolts, designed for the security of searchlight matériel (see fig. 17). The automotive features of these trucks are covered in the maintenance manual for each vehicle.

■ 63. TRAILER M1 FOR THE ANTI-AIRCRAFT SEARCHLIGHT.—*a.* The standard trailer used for the transportation of searchlight equipment is the M1 trailer. It is a four-wheel, pneumatic-tired, low-bed, tilting trailer with integral body (see fig. 18). Its capacity is 4,000 pounds. The four wheels are mounted by pairs in tandem so that the unit will operate as a two-

wheel trailer and have the load capacity of a four-wheel vehicle.

b. The steel deck forward of the front bulkhead provides a mounting for the winch and brake handwheel, and also serves as a means of locking the tilting frame to the drawbar arms (see fig. 19). The drawbar arms are hinged at the rear to permit tilting of the frame when loading and unloading without uncoupling from the truck. The trailer is tilted

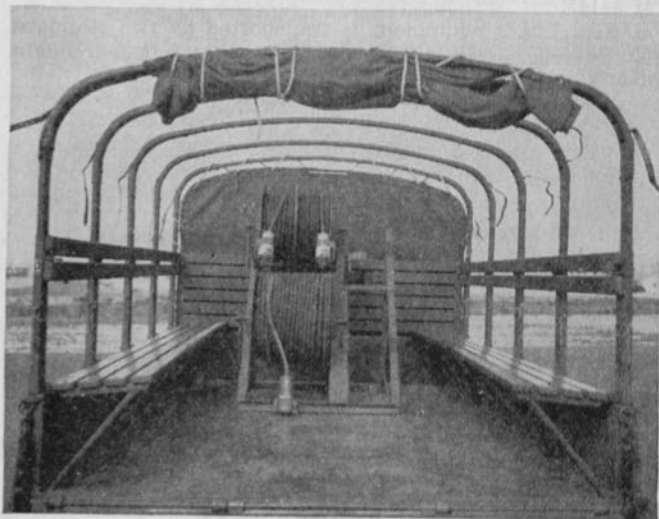


FIGURE 17.—Interior of 2½-ton truck, showing cable reels and seats for personnel.

for unloading by removing the front pins from each side of the winch deck and pushing down on the drawbar arms. The drawbar is equipped with an adjustable rubber tired caster wheel to support the front end when uncoupled from the truck (see fig. 18).

c. A hand-operated, double-cranking winch, with a chain which is hooked to the searchlight, is used in the loading and unloading of the trailer (see fig. 19).



FIGURE 18.—Antiaircraft searchlight trailer M1.



1. Front bulkhead.
2. Steel deck.
3. Winch.
4. Drawbar arms.
5. Front pins.

6. Caster wheel.
7. Drawbar tongue.
8. Safety chains.
9. Break-away chain.
10. Jumper cord.

FIGURE 19.—Antiaircraft searchlight trailer M1 in position for unloading searchlight—front view.

d. Truck and trailer are connected by a lunette at the forward end of the drawbar tongue which fits into a pintle hook at the rear of the truck.

e. Two heavy safety chains connect the drawbar arms with the truck.

f. Mechanical hand parking brakes are operated by means of a handwheel on the trailer front deck.

g. Electric brakes on all four wheels of the trailer are controlled from the cab of the truck. This brake system is provided with standard emergency break-away features.

h. A jumper cord or cable, from truck to trailer, supplies the current for the brake and lamp circuits of the trailer.

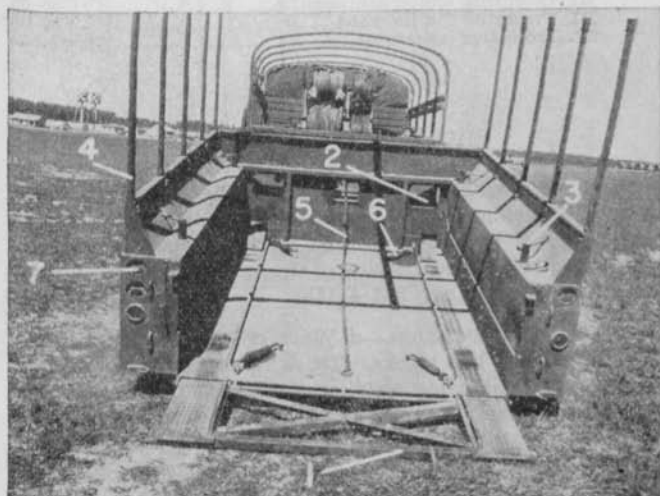
i. The trailer tailgate is hinged at the bottom so that it acts as a ramp for the loading and unloading of equipment (see fig. 20).

j. Each trailer is provided with hold-down devices consisting of four turnbuckles. Hinge doors in the front bulkhead provide access to the forward turnbuckles which fasten the searchlight to the trailer.

k. Corner jacks, which are used when tires or wheels are changed, are fastened to each corner of the frame. They are adjustable by the use of hand cranks extending through the top of the side walls. These corner jacks are also used to stabilize the vehicle when time does not permit the unloading of the light and it must be operated from the trailer.

l. Removable bows and canvas covers completely inclose the body of the trailer.

■ 64. TRANSPORTATION OF POWER PLANT.—The power plant is towed behind truck No. 2 of the searchlight squad. For connecting truck and power plant, the lunette on the forward end of the tow bar of the power plant is locked in the pintle hook at the rear of the truck. The power plant is equipped with safety chains and a standard break-away feature which acts as a safety device in case the power plant should become uncoupled from the truck.



- | | |
|-----------------------------------|--------------------|
| 1. Tailgate (ramp for loading). | 4. Removable bows. |
| 2. Hinged door in front bulkhead. | 5. Winch chain. |
| 3. Hand crank of corner jack. | 6. Turnbuckle. |
| 7. Blackout stop and tail light. | |

FIGURE 20.—Antiaircraft searchlight trailer M1 in position for loading searchlight—rear view.

CHAPTER 5

PREPARATIONS FOR ACTION AND FOR MOVEMENT

	Paragraphs
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SECTION I

PREPARING FOR ACTION

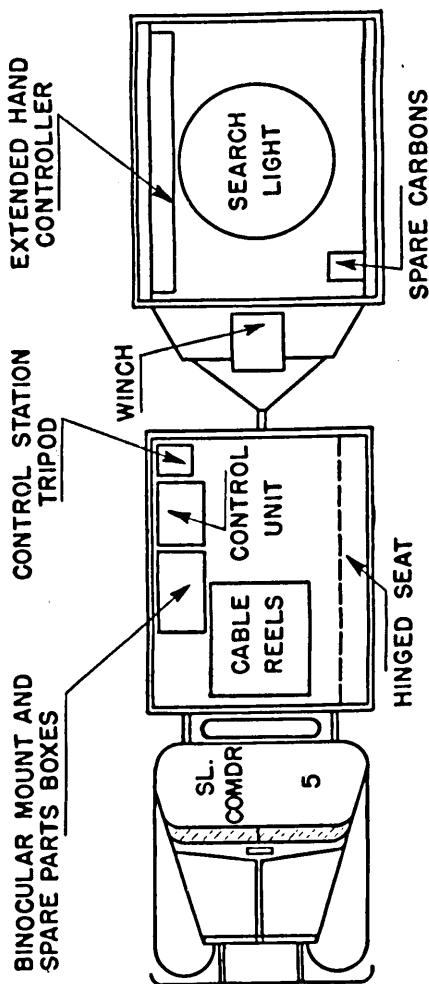
■ 65. SCOPE.—*a.* This section describes the setting up of the detector-searchlight unit equipment from traveling position on the road to operating position ready for action.

b. For a detailed description of the assembly of the detector section equipment, see FM 4-145.

■ 66. TRAVELING POSITION.—*a.* When on the road, the searchlight squad uses two trucks. Truck No. 1 carries the control station unit, the cable reels, and the binocular mount and spare parts boxes. It tows an M1 trailer in which is loaded the searchlight, the extended hand controller, and the spare carbons. Truck No. 2 carries a caliber .50 machine gun completely assembled and mounted for the defense of the vehicles on the road, and five extra chests of ammunition. A two-way radio complete with other radio accessories is also loaded in this vehicle. This truck tows the power plant.

b. The equipment is loaded and the personnel placed according to the arrangement shown in figures 21 and 22.

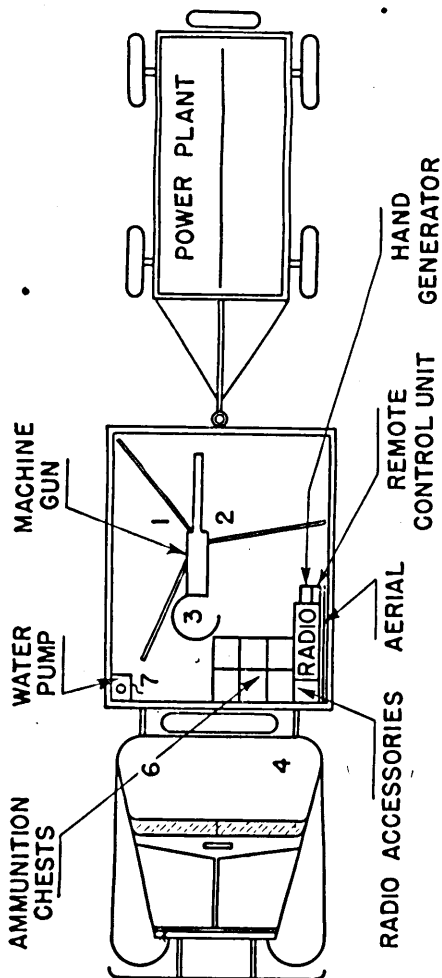
■ 67. SELECTION OF POSITION.—The detector-searchlight section depends on the accuracy of the detector unit for the efficiency of its operation. Consequently, in selecting a position for the section, primary consideration must be given to the factors favorable to detector reception. Within the limitations determined by the tactical situation the position selected should be—



TRUCK NO. 1

SEARCHLIGHT TRAILER MI

FIGURE 21.—Loading of equipment and personnel, searchlight squad (truck No. 1).



TRUCK NO. 2

POWER PLANT

FIGURE 22.—Loading of equipment and personnel, searchlight squad (truck No. 2).

a. On or near a road good enough to permit its use by the trucks in all kinds of weather (or in terrain permitting trucks to move cross-country in all kinds of weather, subject to camouflage discipline).

b. Distant or defiladed from objects that interfere with the radio echo, as metal towers or buildings, bridges, or transmission lines.

c. A "crater" location on a hill. This is an excellent position.

d. At least 1 mile from the nearest antiaircraft gun battery, to avoid drawing enemy fire to the gun battery, and to avoid the effect of glare upon the gun crew. Pick-up lights should be at least 500 yards from roads and railroads upon which there is considerable traffic.

e. Favorably located with regard to security and camouflage.

■ 68. GOING INTO POSITION.—On arrival at the detector-searchlight position, the chief of section indicates the location of the detector and its power plant, the searchlight, the control station, the searchlight power plant, and the machine gun. He gives the necessary instructions to have the matériel prepared for action.

■ 69. ACTIONS OF DETECTOR SECTION AT PREPARE FOR ACTION.—Whenever the detector is moved from one location to another, many parts of the equipment must be disassembled and fastened in their assigned places. The unit therefore arrives at its destination in a packed condition and must be reassembled. For the methods of assembly of the detector unit and preparation of the detector section for action, see FM 4-145 and TF 4-605.

■ 70. ACTIONS OF TRUCK No. 1 AT PREPARE FOR ACTION.—a. At the command PREPARE FOR ACTION, truck No. 1, towing the M1 trailer, proceeds to the vicinity of the indicated searchlight position (see fig. 23), where the trailer is disconnected from the truck and the caster wheel swung down into the parking position. The trailer should be dropped far enough away from the final searchlight position to preclude the possibility

of both the traller and the light being destroyed by a single shell or bomb.

b. After assisting in unloading the machine gun, the chauffeur of truck No. 1 returns to his truck and drives from the searchlight to the control station position. The control station (red) cable is unreeled on the way.

c. At the control station position, the control station is unloaded and set up.

d. From the control station, the truck proceeds successively to the searchlight and the power plant, laying the power plant (yellow) cables on the way.

e. After all cables are laid, the truck is driven to the designated parking area. Here the driver checks gas, oil, and water and assures himself that the truck is hidden from ground and air observation.

■ 71. ACTIONS OF TRUCK NO. 2 AT PREPARE FOR ACTION.—At the command PREPARE FOR ACTION, truck No. 2 proceeds to the power plant position (see fig. 23). The power plant is uncoupled from the truck. The two-way radio is unloaded and set up near the power plant. Truck No. 2 is then driven to the machine-gun position where the machine gun, water pump, and ammunition chests are unloaded. Truck No. 2 then proceeds to the designated parking area, where gas, oil, and water are checked and the truck is hidden from ground and air observation.

■ 72. NORMAL SET-UP FOR DETECTOR-SEARCHLIGHT SECTION.—

a. The usual arrangement in the field for the equipment of the detector-searchlight section is shown in figure 24. A favorable position is that near a little-used road and close to suitable cover for vehicles and personnel.

b. The control station and the searchlight must be placed on level or slightly elevated ground so as to secure a wide field of vision in all directions. The detector is located according to factors outlined in paragraph 67.

c. The control station may be located anywhere within the length of the red cable from the searchlight (500 feet), and the detector may be placed anywhere within the length of the director-adapter cable (260 feet). However, the usual distance between the light and the detector is 75 to 150 feet.

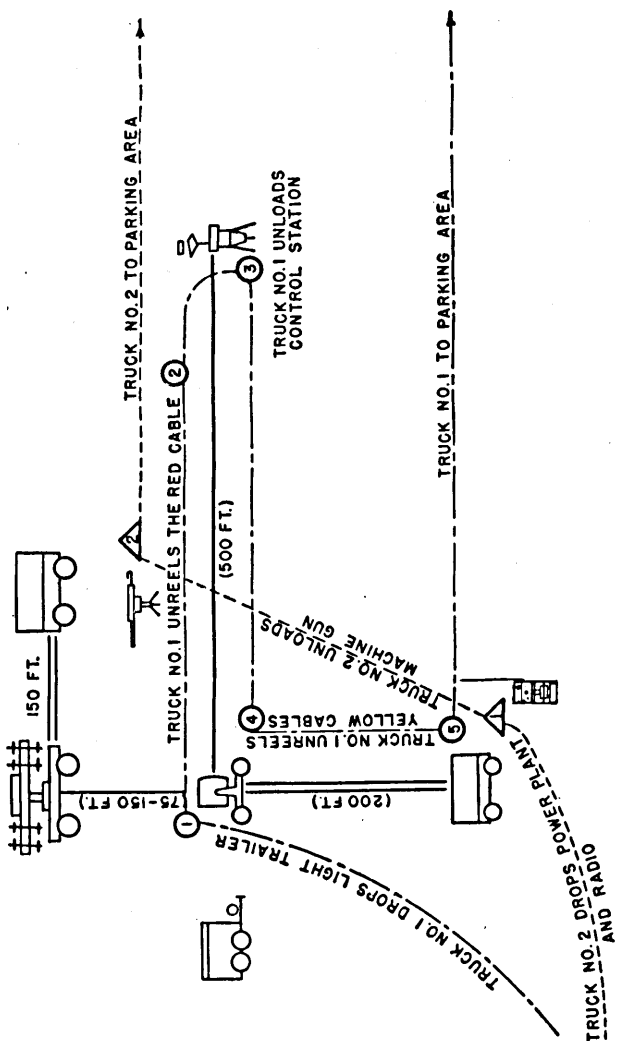


FIGURE 23.—Routes of trucks in field emplacement of equipment of searchlight squad.

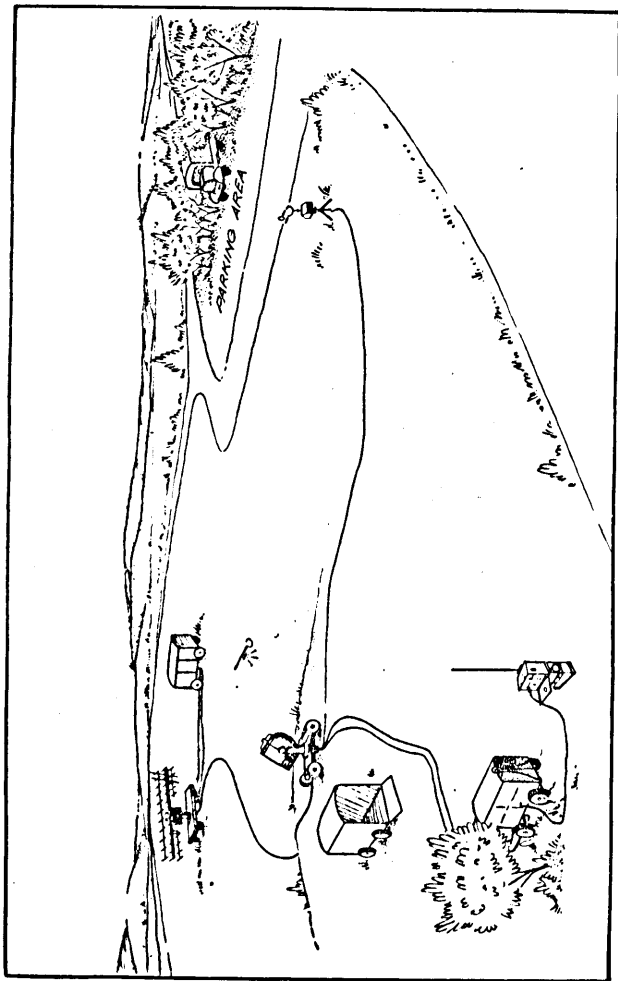


FIGURE 24.—Field emplacement of equipment of detector-searchlight section.

As the detector has no provision for a parallax correction, it is desirable to have light and detector as close together as is practicable, and both on a line with a distant orienting point.

d. The machine gun is sited so as to give an all around protection to all searchlight equipment, particularly the detector unit and the searchlight.

e. The radio is placed near the power plant, the battery of which can be used as a source of power for the dynamotor of the radio. A remote control unit permits two-way radio communication by means of a field telephone located at the detector or any other desired location. However, by the use of the hand crank generator the radio may be placed near the post of the chief of section at the detector. An additional man will then be required to turn the crank of the generator when messages are transmitted. The telephone operator acts as operator of the two-way radio.

f. An alternate arrangement of matériel is illustrated in figure 25. In this set-up the two power plants are located together where one operator may control both. However, in this set-up there is greater danger that both power plants may be destroyed by a single bomb or shell.

■ 73. SETTING UP SEARCHLIGHT.—a. At the command PREPARE FOR ACTION, truck No. 1, towing the M1 trailer, drives up to the vicinity indicated for the searchlight. The hand brake is set on the trailer. The hand locking pin is removed from the caster wheel bracket, and the caster wheel is swung down. The pin is replaced, securing the wheel in the parking position. The wheel is then adjusted to the proper height to clear the pintle hook. The break-away chain, the left safety chain, and the jumper cord are disconnected, and the jumper cord placed in the tool compartment. The lunette is disconnected from the pintle hook and the safety chain on the right is disconnected. The truck is driven clear of the trailer.

b. The trailer is left parked while other equipment is unloaded (see par. 116). Then the trailer tailgate is dropped. The front pins are removed from each side of the winch deck and the trailer tilted by pushing down on the drawbar tongue. The front and rear turnbuckles are loosened and the rear

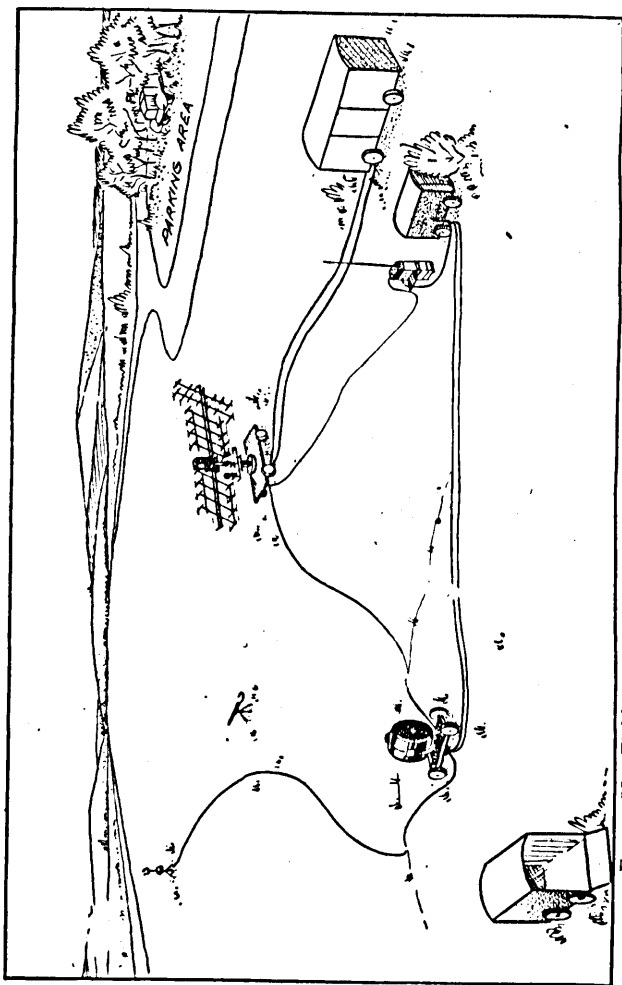


FIGURE 25.—Field emplacement of detector-searchlight section (alternate arrangement).

chocks removed. While the winch is being operated the searchlight is rolled slowly out of the trailer. It may be guided manually at the front wheels. The winch chain is disconnected from the searchlight. The steering tongue is removed from its carrying brackets and attached to the searchlight. The light is then moved to its final operating position and its canvas cover removed.

c. The light is then leveled by means of the four leveling jacks until the level bubble stays centered while the light is traversed 360°.

d. The transportation lock is unpinned at the drum and the lock bar lowered to its horizontal position on the chassis. Since the searchlight is transported with the elevation clutch in "hand" position and with the elevation clamp free, the drum may readily be lowered to zero elevation by hand.

e. The azimuth lock pin is removed so that the searchlight revolves freely. *Caution:* Do not replace the pin except for locking the searchlight in its transporting position as the pin will foul the lock when the searchlight is rotated.

■ 74. SETTING UP CONTROL STATION.—a. After truck No. 1 has been disconnected from its trailer, it is driven to the location chosen for the control station.

b. At this position the tailgate of the truck is lowered and the binocular mount box, the control unit, and the tripod are unloaded. The tripod is set in place and its protective cap removed. The control unit is lifted to a position over the tripod and lowered slowly to its seat. The binocular mount is removed from its box. The coverplate is removed, and the column inserted in its place on top of the control unit. The binocular mount is opened to its operating position and its locking pin inserted. The binoculars are placed in position at the top of the binocular mount. The control station is leveled by adjustment of the leveling jacks.

■ 75. PREPARATION OF POWER PLANT AND RADIO.—a. Truck No. 2 is driven to the power plant position where it is uncoupled from the power plant. The two-way radio, complete in frame with dynamotor, the remote control unit, the antenna, and the field telephone are unloaded. The telephone operator connects the battery cables of the radio to the power plant

battery and inserts the antenna in the insulator. He prepares the radio and remote control unit for communication and lays a wire line from the remote control unit to a point near the detector position where he connects a field telephone. By the use of a microphone and headset he checks operation of the radio communication.

NOTE.—If the section is provided with wire communication from the platoon command post, a field telephone is connected at the wire connection.

b. After driving truck No. 2 to the parking area, the power plant operator returns, connects the yellow cables at the power plant, and prepares it for operation. He checks the supply of gasoline, oil, and water. Before starting the engine he makes the checks described in the Operator's Manual.

■ **76. SETTING UP MACHINE GUN.**—Truck No. 2 carries the machine gun to the position selected for it. The tailgate of the truck is lowered and the assembled machine gun, with water pump and ammunition chests, is unloaded and set up.

■ **77. CABLES, SEARCHLIGHT SQUAD.**—*a.* Multiconductor cables connect the power plant, light, control station, and detector. For identification, the plugs of these cables are painted different colors as follows:

(1) *Yellow.*—Two single-conductor main power cables connecting light and power plant. These carry the power for the searchlight.

(2) *Red.*—A 15-conductor cable connecting the control station with the light. It transmits the distant electric control impulses from the control station to the elevation and azimuth motors on the light. It transmits the zero reader data from the light to the control station. It also connects a push button on the control station with a buzzer on the searchlight.

b. The director-adapter combination cable, which connects the detector and the searchlight, is a 19-conductor combination cable made from joining cables Nos. 27 (director) and 28 (adapter), both of which are part of the equipment of the detector section. This combination cable fits into the blue receptacle at the searchlight junction box. It trans-

mits to the searchlight the azimuth and angular height as determined by the detector.

c. The power cables (yellow) and control station cables (red) are carried on reels and are transported in truck No. 1 which tows the trailer. The reels are mounted in racks which are bolted to the body of the truck in a permanent position. The director-adaptor cable is carried with the detector equipment.

d. Where practicable, cables are laid from the body of the truck. Where impractical, the cables are laid by detaching the reels from the racks, placing the reels on the ground near the searchlight, and laying the cable by rolling the reel to the element of equipment. It is sometimes necessary to place additional men along the cable to keep it from binding or becoming snagged.

■ 78. PRECAUTIONS ON HANDLING CABLES.—a. As a high percentage of searchlight matériel failures are caused by cable difficulties, it is imperative that cables be handled with great care. Most cable failures take place within a foot of the plugs, which indicates that rough handling of the cable at the plug is a major source of difficulty. It has been found by actual experience that the observance of the rules given in b below greatly reduces cable failures.

b. (1) Plugs should be removed from receptacles by pulling on the *plug*, not on the cable. Pulling on the cable will bend and break the soldered electrical connections at the plug.

(2) When moving the cables, pull on the *cable*, not on the plug. Pulling on the plug will rupture the electrical conductors.

(3) When moving the cables, do not allow the plugs to drag along the ground, catching on rocks, bushes, and other obstructions. Carry the cable so the plug is clear of the ground.

(4) Do not lay the cable so that it is likely to be run over by vehicles.

(5) Do not kink the cables.

(6) Do not operate the searchlight with the main power cable (the one with yellow plugs) on the cable reels. In-

sufficient ventilation may cause the cables to overheat and destroy the rubber insulation.

(7) Do not be in too much of a hurry to reel up the cables when march order is given. A few minutes saved the night before may cause hours of repair work the next day.

(8) Do not put cable plugs into receptacles until cables are completely laid and off the cable reels.

(9) In hot climates, deterioration of cables can be greatly reduced by burying them 4 inches underground in order to protect the cables from rain and from the sun's rays.

(10) In digging a shallow channel, or ditch, for a cable, one side wall of the ditch should be constructed in the form of a ledge or step 4 inches from the surface. The cable is then laid on this step. The lower part of the ditch provides drainage for the cable and helps preserve it.

NOTE.—When a searchlight is in action for prolonged periods, the buried power plant cables should be checked for excessive heating, due to the heat loss in the cables as the result of 165 amperes of direct current passing through them.

(11) In cold climates, it is best to leave cables above ground unless sufficient time is available to build troughs in which to place the cable underground. Many cables have been rendered unserviceable while they were being removed from the frozen ground.

■ 79. LAYING CABLES.—*a.* Cables are carried in truck No. 1, which tows the trailer.

b. The control station (red) cables are laid first. Truck No. 1 drops the searchlight trailer, then is driven to the control station while the control station cable is unreeled on the way.

c. Truck No. 1 is driven to the searchlight position. Both yellow cables are laid at the same time as the truck moves slowly from the light to the power plant. During the laying operation there should be at least one man for the reel on the truck and a man on the ground to guide the cables as they are unreeled. *Do not put cable plugs in receptacles on power plant until all cables are completely laid and off the truck.*

d. The combination director-adapter cable is part of the equipment of the detector section. It is laid between the searchlight and the detector by members of the detector crew.

e. At the power plant, the light, the control station, and the detector, the cable plugs are connected to their proper receptacles. These receptacles are painted the same color as the plugs to facilitate identification.

SECTION II

ORIENTING AND SYNCHRONIZING

■ 80. SCOPE.—This section describes methods of orienting and synchronizing the various elements of the detector-searchlight section.

■ 81. GENERAL.—The searchlight and detector must be oriented and synchronized in azimuth and elevation. Orientation may be accomplished using an azimuth referred to north, or an arbitrary zero azimuth. Because the detector is a primary source of information in the AAAIS, and because, in a coordinated defense of an objective, it is necessary to orient all detector-searchlight units relative to one another, it is often found desirable to orient the detector in azimuth referred to north. Therefore, in the description following, such an azimuth is used. It is assumed that the searchlight and detector have been set up and proper electrical connections made.

■ 82. PREPARATION OF DETECTOR FOR SYNCHRONIZATION.—This description of orientation and synchronization should be studied in connection with the corresponding subject matter in FM 4-145 and TF 4-609, 4-610. The following steps will be taken at the detector, but not necessarily in the order given, before the searchlight unit matériel is synchronized.

a. The azimuth antenna will be aligned with the physical axis of the detector mount and with the sight.

b. The elevation antenna will be aligned with the physical axis of the detector mount and with the sight, and the angular height counter adjusted to indicate the true angular height of the electrical axis.

c. Range orientation will be completed.

d. The azimuth ring of the detector will be oriented. North is determined by the use of a magnetic compass, by sighting on Polaris with the sight, or from a map. These methods are sufficiently accurate for the determination of the azimuth used by the detector-searchlight unit. The azimuth ring is turned until zero is under the index pointer.

■ 83. ORIENTING AND SYNCHRONIZING IN AZIMUTH ON DISTANT POINT.—*a. Orienting in azimuth.*—One method of orientation in azimuth is by the use of a celestial body (sun, moon, or a star) or a distant object as the orienting point. In this method, detector, searchlight, and control station are pointed at the celestial body or distant point by means of their sights. The procedure by which the various elements of matériel are oriented is as follows:

(1) *Detector.*—The detector is pointed at the orienting point by means of the sight (see fig. 26).

(2) *Searchlight.*—(a) Disengage the azimuth clutch by pulling the azimuth clutch lever in the direction indicated as "Out" on the Sperry searchlight and indicated as "Hand control", on the General Electric searchlight.

(b) Turn the searchlight in azimuth until it points at the orienting point, sighting by means of the orienting sight on the searchlight (see fig. 26).

(c) Reengage the azimuth clutch by pushing the azimuth clutch lever in the direction indicated as "In" on the Sperry searchlight and as "Distant electric control" on the General Electric searchlight.

(d) Start the power plant (Sperry) and turn the red d-c switch at the control station "On." On the General Electric searchlight, start the power plant and turn the "Distant electric control" switch at the control station to "On"; be sure that the dynamotor switch is "On" and the dynamotor is running, as this D. E. C. system uses 110 volts a-c.

(e) Recheck the searchlight azimuth position. If necessary, use the distant electric control at the control station to reset the searchlight to the orienting point.

(f) Set the searchlight azimuth scale to the azimuth of the orienting point (azimuth indicated at the detector). To

do this, loosen the screw of the azimuth scale located at the base of the searchlight and turn the azimuth scale until the proper azimuth appears under the index pointer. Tighten the screw.

(3) *Control station.*—(a) In orienting the control station, set the binocular mount to the azimuth zero reference mark, then slew the control unit around on its tripod (a friction clutch allows this to be done without turning the handwheels) until the binoculars are directed at the orienting point (see fig. 26). After orientation has been completed, care should be taken not to move or jolt the control unit.

(b) If the orienting point being used by the searchlight and the detector is not visible from the control station, point the searchlight at any distant object by means of the distant electric control. Set the binocular mount of the control station to the azimuth zero reference mark, then slew the control unit around on its tripod until the binoculars are directed at the distant object.

b. *Synchronizing in azimuth.*—(1) When the detector and the searchlight have been oriented as described in *a* above, the azimuth zero readers on the searchlight and control station may or may not show a zero reading. They should be made to read zero by removing the cover on the azimuth data receiver adjustment knob (synchronizing knob) at the base of the searchlight, loosening the lock nut, and turning the adjustment knob. On the General Electric searchlight, loosen the clamp screw and turn the "Azimuth corrector knob" on top of the searchlight turntable.

(2) It is possible to obtain two zero readings by rotating the azimuth data receivers to two positions 180° apart. The correct zero reading is obtained when the needle of the azimuth zero reader at the control station moves to the "right" when the zero reader handwheel is rotated clockwise and to the "left" when the handwheel is rotated counterclockwise. If the needle moves in the opposite direction to that of the control station handwheel, return it to zero, and then holding the searchlight on the orienting point, turn the synchronizing knob continuously in one direction until the needle moves off the scale and then returns to zero reading.

(3) Traverse the detector steadily and at the same time

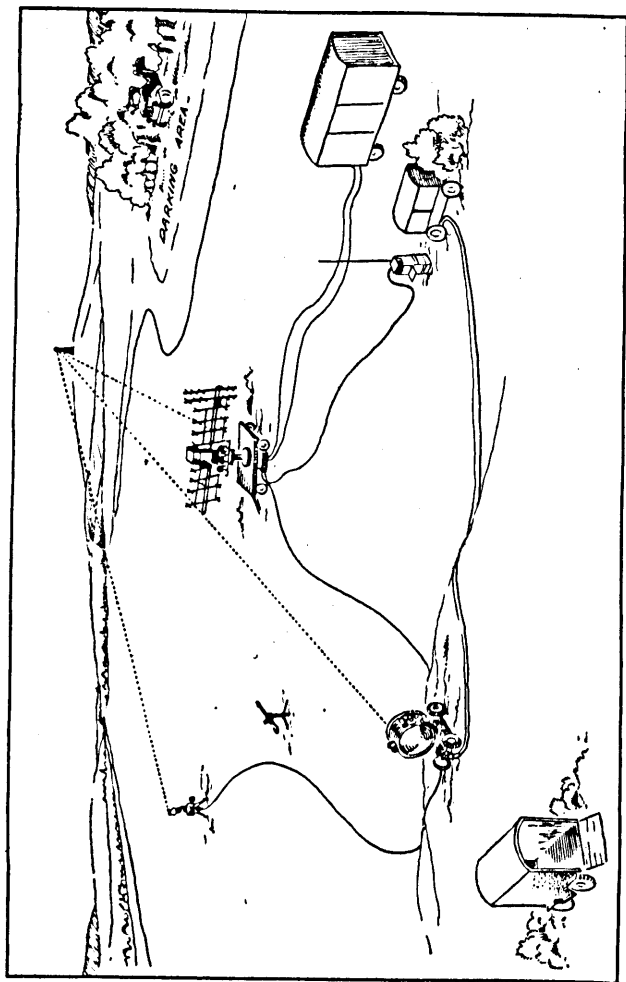


Figure 26.—Orienting in azimuth on a distant point, detector-searchlight section.

keep the zero readers centered at the control station by means of the azimuth distant electric control handwheel. The direction of rotation of the searchlight should be the same as the detector, that is, a clockwise rotation of the detector should result in a clockwise rotation of the searchlight. If the direction of rotation is incorrect, it will be necessary to throw the "Coarse azimuth Selsyn" reversing switch in the terminal box on the detector.

(4) *If the reversing switch at the detector is thrown it will again be necessary to orient and synchronize the detector, searchlight, and control station in azimuth as described above.*

■ 84. ORIENTING AND SYNCHRONIZING IN ELEVATION.—*a. Orienting in elevation.*—(1) *Detector.*—The detector is elevated until the angular height counter indicates zero mils and is held stationary.

(2) *Searchlight.*—(a) Turn the searchlight elevation D. E. C. control clutch lever to "Hand" position and set the searchlight to zero elevation by hand.

(b) Reengage the elevation D. E. C. control clutch lever by turning the clutch lever to the "Distant electric control" position. *Do not force the clutch lever*; if it will not move easily into the "Distant electric control" position, keep a slight pressure on the lever and slowly rock the searchlight a few mils in elevation until it does. By means of the distant electric control, from the control station, reset the searchlight to zero elevation if necessary.

(3) *Control station.*—Set the binocular mount to the elevation zero reference mark. After the binocular mount has been set to zero elevation it should not be moved or jolted.

b. Synchronizing in elevation.—(1) The elevation zero readers on the searchlight and control station may or may not read zero. They should be made to read zero by turning the "Coarse elevation Selsyn" adjustment in the elevation Selsyn housing of the detector.

NOTE.—Because the General Electric searchlight is not equipped with an elevation synchronizing knob on the elevation data receiver, it is of advantage to synchronize in elevation at the detector rather than at the searchlight. However, synchronizing in elevation may be accomplished at the Sperry or the General Electric searchlight as described in (2) below.

(2) Synchronizing may be made at the Sperry searchlight by removing the cover on the elevation data receiver adjustment knob (synchronizing knob) located on the left trunnion arm of the Sperry searchlight, and turning the synchronizing knob. To synchronize at the General Electric Searchlight, it is necessary to remove the cover of the elevation data receiver housing on the left trunnion arm, then loosen the three stator screws and rotate the stator of the elevation data receiver.

(3) It is possible to obtain two zero readings by rotating the elevation data receiver stator to two positions 180° apart. The correct zero reading is obtained when the needle of the elevation zero reader at the control station moves to the "right" when the elevation handwheel is rotated clockwise and to the "left" when the handwheel is rotated counterclockwise. If the needle moves in the wrong direction, return the searchlight to zero elevation and turn the "Coarse elevation Selsyn" adjustment at the detector continuously in one direction until the needle moves off the scale and then returns to zero reading again.

NOTE.—The detector "Coarse elevation Selsyn" adjustment has a stop limiting rotation which may be encountered in adjusting for the correct zero reading. If the stop is encountered, rotate back to the first zero position and then rotate continuously in the other direction until the needle moves off scale and then returns to zero reading again.

(4) Elevate the detector slowly and at the same time keep the zero reader centered by means of the elevation handwheel. The searchlight should also elevate. If the searchlight does not follow in elevation, it will be necessary to throw the "Coarse elevation Selsyn" reversing switch in the terminal box on the detector.

(5) *If the reversing switch at the detector is thrown it will again be necessary to set both the detector and the searchlight at zero elevation and again to zero the zero readers as outlined in (1) and (2) above. In this case, it will also be necessary to check for the correct zero reading as outlined in (3) above.*

■ 85. CHECK ON SYNCHRONIZATION.—*a.* If a friendly airplane is available, it is desirable that a check on the synchronization of the detector with the searchlight be made.

b. For details of the method to be followed in this check, see FM 4-145 and TF 4-609, 4-610).

■ 86. ORIENTATION AND SYNCHRONIZATION BY BACKSIGHTING.—Normally the field position selected will permit orientation on a distant point. However, if use of a distant point is impracticable, the unit may be oriented and synchronized by backsighting as follows:

a. Orienting in azimuth by backsighting.—(1) *Detector and searchlight.*—(*a*) Direct the detector toward the searchlight (see figure 27).

(*b*) Sight directly through the vertical axis of the searchlight (as over the azimuth data receiver housing) at the vertical column of the detector. Drive two stakes at each end of this line—one in the front of searchlight (stake "A") and one in the front of detector (stake "B").

(*c*) Measure the distance between the vertical column of the detector and the detector sight (this distance varies with different models) and place a stake (stake "C") at this same distance to the left (left from direction of searchlight) of stake in front of searchlight (stake "A").

(*d*) Similarly, measure the distance between the vertical axis of the searchlight and the orienting sight on the left side of the searchlight. Place a stake at this distance (stake "D") to left of stake in front of the detector (stake "B").

(*e*) Traverse the detector until the detector sight is directly on stake "C".

(*f*) Disengage the azimuth clutch of the searchlight and turn the light in azimuth until it points at stake "D" (use orienting sight).

(*g*) Reengage the azimuth D. E. C. clutch.

(*h*) Start the power plant and turn the D. E. C. switch at the control station to "On."

(*i*) Recheck the searchlight azimuth position using distant electric control to bring the searchlight exactly on stake "D." Now the detector and searchlight sights are parallel to the line of centers.

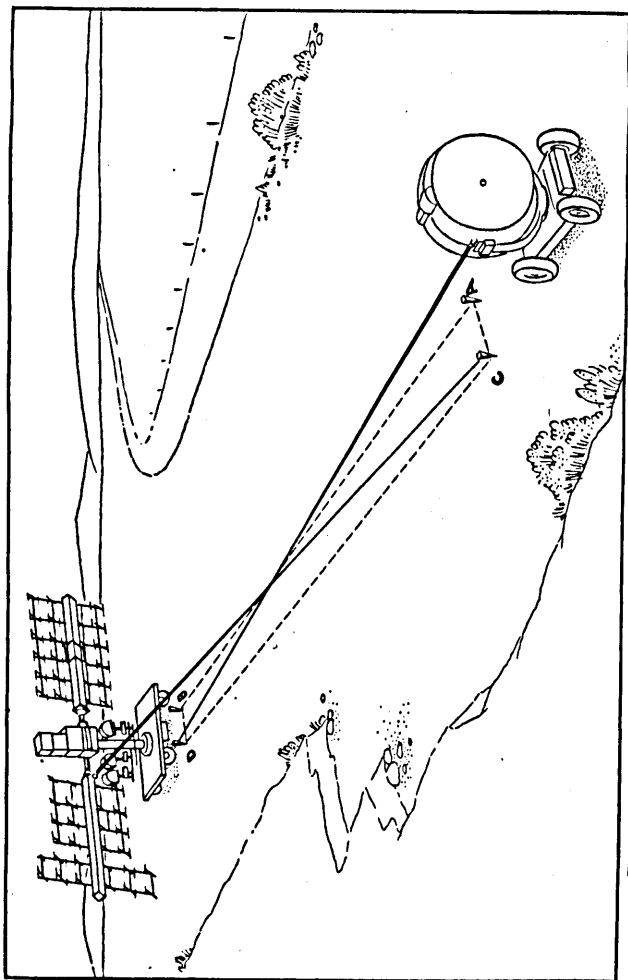


FIGURE 27.—Orienting in azimuth by backsighting. Searchlight and detector.

(j) Set the searchlight azimuth scale to 3,200 mils and the detector azimuth scale to zero.

(k) Using the distant electric control, turn the searchlight to zero azimuth.

(2) *Control station.*—(a) Direct the searchlight at the control station by using the distant electric control. Sight the searchlight exactly on the control station, using the light's orienting sight (see fig. 28).

(b) Set the binocular mount to the azimuth zero reference mark.

(c) Slew the control unit around on its tripod until it is backsighted on the searchlight. This is accomplished by sighting backward through the open sight on the binoculars.

(d) Return the searchlight to zero azimuth.

b. *Synchronizing in azimuth.*—See paragraph 83b.

c. *Orienting and synchronizing in elevation.*—See paragraph 84.

d. *Orienting in azimuth referred to north.*—After the equipment of the section has been oriented and synchronized as described in this paragraph, the detector is traversed until its sight is directed toward zero azimuth referred to north (see also par. 82d). Checking carefully that the zero readers at the searchlight and the control station are centered, then set the azimuth scales at both the detector and the searchlight to zero.

■ 87. ORIENTATION AND SYNCHRONIZATION WITH THE TWEETER.—See FM 4-145 and TF 4-609 and 4-610 for the method of orientation and synchronization using the tweeter or test modulator.

■ 88. ORIENTATION OF SEARCHLIGHT UNITS WITHOUT DETECTORS.—When a searchlight unit is not equipped with a detector, there is no synchronization involved between the searchlight and the control station.

a. *Orienting in azimuth on a distant point.*—(1) *Searchlight.*—See paragraph 83a(2) except (f) in which procedure is as follows: Set the searchlight azimuth scale to zero (or to the azimuth referred to north of the orienting point). To do this, loosen the screw of the azimuth scale located at the base of the searchlight and turn the azimuth scale until

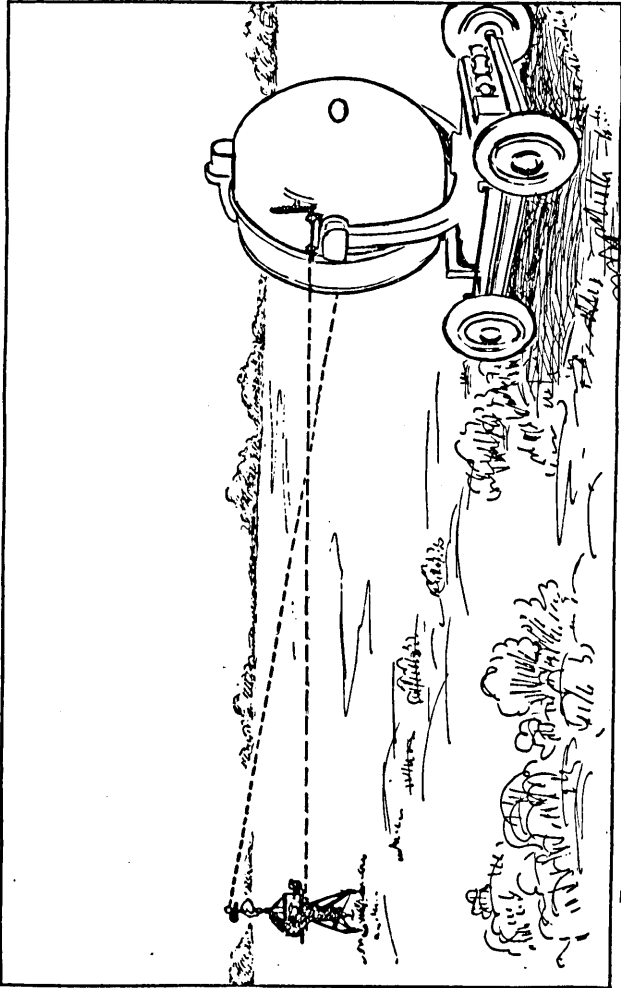


FIGURE 28.—Orienting in azimuth by backsighting. Searchlight and control station.

the proper azimuth appears under the index pointer. Tighten the screw.

(2) *Control station*.—See paragraph 83a(3).

b. *Orienting in elevation*.—(1) *Searchlight*.—see paragraph 84a(2).

(2) *Control station*.—See paragraph 84a(3).

c. *Orienting in azimuth by backsighting*.—(1) *Searchlight*.—

(a) Disengage the azimuth clutch by pulling the azimuth clutch lever in the direction indicated as "Out" on the Sperry searchlight and indicated as "Hand control" on the General Electric searchlight.

(b) Turn the searchlight in azimuth until it points exactly at the control station, sighting by means of the orienting sight on the searchlight.

(c) Reengage the azimuth clutch by pushing the azimuth clutch lever in the direction indicated as "In" on the Sperry searchlight and as "Distant electric control" on the General Electric searchlight.

(d) Start the power plant (Sperry) and turn the red d-c switch at the control station "On." On the General Electric searchlight, start the power plant and turn the "Distant electric control" switch at the control station to "On"; be sure that the dynamotor switch is "On" and the dynamotor is running, as this D. E. C. system uses 110 volts a-c.

(e) Recheck the searchlight azimuth position. If necessary, use the distant electric control at the control station to set the searchlight exactly on the control station.

(f) The azimuth scale will normally be set to zero but may be set to azimuth referred to north. To make this setting, loosen the screws at the azimuth scale located at the base of the searchlight and turn the azimuth scale until zero (or the proper azimuth) on the scale is under the index pointer. Tighten the screw.

(2) *Control station*.—The searchlight is sighted at the control station as described in (1) (b) above. In orienting the control station, set the binocular mount to the zero azimuth reference mark, then slew the control unit around on its tripod (a friction clutch allows this to be done without turning the handwheels) until it is backsighted on the searchlight. This is accomplished by sighting backward through

the open sight on the binoculars. The control station is now oriented in azimuth, that is, pointed in the same direction as the searchlight.

d. Orienting in elevation by backsighting.—(1) *Searchlight.*—See paragraph 84a(2).

(2) *Control station.*—See paragraph 84a(3).

SECTION III

PREPARING FOR THE ROAD

■ 89. SCOPE.—*a.* This section describes the disassembling and loading of the equipment of the searchlight-detector section preparatory to a move by road.

b. For a detailed description of the disassembly and packing of the detector section equipment see FM 4-145 and TF 4-606.

■ 90. OPERATING POSITION.—When the command MARCH ORDER is given, the light unit is in operating position with the crew distributed as shown in figure 3. The detector trailers and the searchlight trailer are in the section position. The prime movers and trucks are in the parking area hidden from observation.

■ 91. ACTIONS OF TRUCK No. 1 AT MARCH ORDER.—*a.* At the command MARCH ORDER, truck No. 1 is driven from its parking area to the power plant position. The yellow cables from the power plant to the searchlight are reeled in as the truck moves to the searchlight.

b. The truck is then driven to the control station which is disassembled, loaded on the truck, and fastened in place by hold-down devices.

c. From the control station the truck is driven to the searchlight position, the red cable being reeled in on the way. The searchlight is placed in traveling position, loaded in the trailer, and fastened in place by means of the four turn-buckles provided. The trailer is coupled to the truck.

d. Truck No. 1 then proceeds to its designated position on the road and awaits further orders.

■ 92. ACTIONS OF TRUCK No. 2 AT MARCH ORDER.—*a.* At the command MARCH ORDER, truck No. 2 is driven from the parking

area to a position convenient for the loading of the machine gun. When the entire section is almost ready for the road, the complete machine gun with ammunition chests and water pump is loaded in the truck.

b. The assembled radio and its accessories are placed in the vehicle.

c. The power plant is then coupled to truck No. 2 and the truck proceeds to its designated position on the road behind truck No. 1.

d. When ready to move off, the equipment and personnel should be loaded in the two trucks as shown in figures 21 and 22.

■ 93. LOADING CONTROL STATION.—a. At the command MARCH ORDER, the red cable is disconnected and the binoculars are removed from the mount and placed in their carrying case in the binocular mount box.

b. The binocular mount and open sight are removed from the control unit and replaced in the binocular mount box.

c. The control unit is lifted from the tripod.

d. The tripod is collapsed.

e. The parts of the control station are then loaded in their proper places on truck No. 1 and secured by means of the hold-down devices.

■ 94. PREPARATION AND LOADING OF SEARCHLIGHT.—a. At the command MARCH ORDER, the red, yellow, and director-adaptor cables are disconnected; the light is traversed to the proper position and the azimuth locking pin inserted in the searchlight base; the searchlight is elevated to approximately 1,600 mils and the transportation lock is attached to the drum.

b. It is most important that the elevation clamp is free and the elevation clutch is in the "hand" position and the azimuth clutch in the "out" position.

c. The steering tongue is pinned in place and the jacks run up. The canvas cover is replaced.

d. The searchlight is moved to the trailer, where it is connected to the winch chain. The spare carbons box is placed in the trailer and the steering tongue and extended hand controller placed in the carrying brackets. The winch is operated to pull the searchlight slowly into the trailer. It

may be guided manually at the front wheels. The light is fastened by the front and rear turnbuckles and the tailgate raised.

e. The trailer is lowered by pulling up on the drawbar tongue; the pins are fastened on each side of the winch deck; the drawbar is lowered and the trailer brought to the horizontal.

f. As the truck is backed into position, the hand locking pin is removed from the caster wheel bracket and the caster wheel swung up and secured in traveling position. The lunette is connected to the pintle hook. The safety and break-away chains are connected and the jumper cord obtained from the tool compartment and connected. Truck No. 1 tows the trailer to the designated position on the road.

■ 95. RADIO AND POWER PLANT AT MARCH ORDER.—a. At the command MARCH ORDER, the power plant motor is shut off, the yellow cables disconnected, and the switchboard and radiator doors lowered and fastened.

b. After the machine gun is loaded, truck No. 2 is driven to the power plant position. Meanwhile the field telephone has been disconnected and the wire picked up.

NOTE.—If the section is provided with wire communication from the platoon command post, the field telephone is disconnected at the wire connection. The radio battery cables are disconnected from the power plant battery and the radio prepared for traveling. The assembled radio, antenna, remote control unit, and field telephone equipment are loaded in the truck.

c. Then the power plant is coupled to the truck and the truck is driven to its designated position on the road.

■ 96. LOADING CABLES.—a. At the command MARCH ORDER, truck No. 1 proceeds to the power plant position. The yellow cables are reeled in as the truck moves forward from the power plant to the control station. From the searchlight, truck No. 1 is driven to the control station position. After the control station is loaded, truck No. 1 moves back to the searchlight trailer, reeling in the red cable on the way.

b. The combination director-adaptor cable is reeled in by

members of the detector crew and loaded in the power trailer of the detector section.

SECTION IV

PROTECTIVE MEASURES

■ 97. GENERAL.—For a discussion of the various protective measures as applied to searchlight equipment and matériel, see FM 4-105 and FM 5-20.

■ 98. CONCEALMENT OF SEARCHLIGHTS AND ACCESSORIES.—Because of its bulk, this type of equipment is best concealed in woods or buildings when not in use and moved into operating position during twilight. The detector section, however, will be operating during daylight hours as well as at night, and precautions must be taken to make its position as inconspicuous as possible by using existing roads whenever possible and by selecting positions which will provide the best opportunity for camouflage, consistent with the accomplishment of the assigned mission.

■ 99. CAMOUFLAGE OF SEARCHLIGHTS.—*a.* Camouflage may be used for the daytime concealment of searchlights and accessories in position. Mobile lights may be withdrawn just prior to daylight to concealed positions, if available within a reasonable distance, and returned to the operating position at twilight. The detector units will be camouflaged in position.

b. The strict enforcement of camouflage discipline is essential for the concealment of matériel left in position in the field and for the security of matériel and personnel withdrawn to concealed positions. Camouflage discipline involves keeping personnel from disclosing the location of the position by paths or by the tracks of vehicles; repairing or changing covering material when necessary; keeping men under concealment when enemy airplanes are overhead; not allowing smoke to appear near the position; not allowing trucks or other vehicles to stop in daylight on the road near the position; and not permitting transportation to turn around near the position.

■ 100. COVER FOR SEARCHLIGHT.—*a.* Cover is the means employed for the prevention of injuries to personnel or matériel.

b. Protection will be given to searchlight matériel and personnel by the digging of circular pits or erecting sandbag parapets of such depth or height as will not obstruct the operation of the equipment. The power plant may be given protection by locating it in woods, a ravine, or a depression, with defilade from enemy fire. If, because of limited cable length, cover is not available for the power plant, it should be given artificial protection.

c. Personnel will also be protected by providing slit trenches near each element of the equipment, and in sufficient number to provide cover for the maximum personnel which may be present at that point of the field at any time. The slit trenches should be constructed in the shape of an L, 8 feet on each side, about 20 inches wide and 4½ feet deep. The crew takes refuge in these trenches whenever, during a bombardment, it is not necessary to operate the unit.

■ 101. DISPERSION.—The massing of the vehicles and the personnel of searchlight units should be avoided in bivouac parking areas, in position, or on roads. Maximum use should be made of dispersion, consistent with the accomplishment of the mission and considering other defense measures.

■ 102. DEFENSE AGAINST CHEMICAL ATTACK.—Details of defense against chemical attack are given in FM 21-40, and details on methods of decontamination are given in FM 3-5.

CHAPTER 6

SERVICE OF THE PIECE

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SECTION I

SEARCHLIGHT PLATOON ACTION

■ 103. CONTROL OF SEARCHLIGHT ACTION.—Control of the action of the detector-searchlight section may be retained by the platoon commander or decentralized to the chiefs of section.

■ 104. DECENTRALIZED CONTROL.—When control is decentralized, the responsibility for the selection, pick-up, and carrying of targets belongs to the chiefs of section. In this case the chiefs of section each act independently in selecting, tracking, and illuminating targets, and the searchlight commanders in charge of the two squads which are not equipped with detectors act according to their own initiative and judgment. Or if such instructions are available, they follow the course of action prescribed in the standard operating procedure of their battalion or central controlling agency.

■ 105. SELECTION OF TARGETS.—The platoon commander, chiefs of section, and searchlight commanders should be thoroughly familiar with types and formations of aircraft and their identification. In each situation the platoon commanders and the chiefs of section should know the mission of the antiaircraft defense and the general location of all adjacent elements involved.

■ 106. WARNING COMMAND.—On receiving information of the presence or approach of a hostile target from a chief of section, or from higher echelons, the platoon commander sends to all units of his platoon the command STAND BY.

■ 107. TRACKING.—*a. Centralized control.*—As soon as the target has come within tracking range, it will be assigned to those searchlight units covering that sector and they will be ordered to commence tracking. The assignment of the target will include, when known, the azimuth, slant range and altitude of the target. For example, a complete assignment of target command would be: TARGET; AZIMUTH 1,200; RANGE 25; ALTITUDE 4.

b. Decentralized control.—As soon as the range operator of the detector section selects a target, the chief of section assigns it for tracking to his section.

■ 108. LIGHT ACTION.—*a. (1) Centralized control.*—As soon as the target is within range of one or more lights that have been tracking it, the platoon commander puts such lights as he may elect in action by the command, LIGHT, NO. ——— IN ACTION, OR ALL LIGHTS IN ACTION.

(2) Decentralized control.—As soon as the chief of section of the pick-up light nearest the target estimates that the target is within range, he commands: IN ACTION. Other pick-up lights in range immediately go into action, unless otherwise specified in the standard operating procedure.

b. While friendly aircraft, and in some situations certain types of hostile aircraft, should not be illuminated, the commander should not wait for positive visual or radio identification to go into action. If at any time after the searchlights go into action the target is identified as one that should not be illuminated, all lights are put out of action. Such procedure will depend upon the nature of the searchlight battery's defense mission.

■ 109. CARRYING THE TARGET.—*a.* After the target is picked up, a minimum of two carry lights will normally illuminate it.

b. It is most important that, in the movement of the carry beam to an already illuminated target, the movement of the beam be deliberate and careful. A rapidly moving shaft slashing across a pick-up or illuminating beam often results in the loss of the target or interference with the illumination to a point that gun batteries employing visual firing methods are seriously delayed in opening effective fire.

c. The carry lights remain on the target until it is shot down or flies out of range, or until other carry lights located in the direction of flight have taken it over.

■ 110. **SEARCHING WITH OTHER LIGHTS.**—When the lights from an adjacent platoon go into action, the platoon commander commands: **STAND BY.**

■ 111. **COORDINATION OF DEFENSE.**—When the platoon is a part of a larger unit, the commander of the larger unit will issue such orders involving the functioning of the platoon as are necessary to make it a part of a coordinated defense.

SECTION II

DUTIES OF PERSONNEL

■ 112. **PLATOON COMMANDER.**—*a.* The platoon commander is responsible for the technical training and efficiency of the personnel and for the condition of the matériel assigned to his platoon.

b. He is usually responsible for the tactical handling of the platoon. This involves the choice of which target to illuminate, how many lights to use for searching and how many for carrying, when to change targets, and when to decentralize control to the chiefs of section.

c. The platoon commander normally selects the positions for the individual light units.

d. He specifies the communication net that will be established.

e. For details as to tactical handling, selection of positions, and communication nets, see FM 4-105.

■ 113. **CHIEF OF SECTION.**—*a.* The chief of section (a section sergeant) is in command of one of the detector sections of the searchlight platoon and acts as chief of the combined detector-searchlight section. He is responsible for the efficiency and training of the personnel, and the condition of the matériel under his charge.

b. The chief of section will ordinarily select targets and determine the proper time for illuminating them. It is important that he assure himself that the detector operators

are definitely tracking the target before giving IN ACTION. In case of failure of the communication system, he will always go into action on his own initiative. If the command SECTION LEADER'S ACTION has been given or if communication has failed, the chief of section will assume the responsibility of selection and illumination of targets. In such cases he will be guided by the same considerations as the platoon commander.

c. He normally selects the exact locations for the detector mount and power trailer, control station, searchlight, machine gun, and power plant (either alone or in conference with the platoon commander).

d. He supervises the service of the piece, including going into and out of position. He gives the commands PREPARE FOR ACTION, EXAMINE EQUIPMENT, TRACK, IN ACTION, and MARCH ORDER to all elements of the section. In addition he gives the necessary commands for testing operation and searching the sector to the personnel of the detector section.

e. He personally directs the work of care and preservation of the equipment assigned to the detector section.

f. He directs the orienting and synchronizing of the detector with other units of searchlight equipment.

g. He selects the parking place of the trucks, and after all equipment is unloaded he orders the chauffeurs to park the vehicles at this designated place.

■ 114. SEARCHLIGHT COMMANDER.—a. The searchlight commander (a corporal) commands the searchlight squad. He is responsible for the efficiency of the control station crew, the machine-gun crew, the telephone operator, the searchlight operator, and the power plant operator; and for the condition of the control station, searchlight, machine gun, radio, and power plant.

b. Acting as control station observer, he supervises the search for the target, when necessary, and carries the target after it is picked up.

c. He is responsible for orienting and synchronizing the searchlight and control station with the detector.

SECTION III

DRILL OF THE DETECTOR-SEARCHLIGHT SECTION

■ 115. SCOPE.—This section outlines a drill for an anti-aircraft detector-searchlight section, mobile or semimobile. The duties of the chief of section, and of the searchlight squad of the detector-searchlight section, are herein covered. For performance of duties by the personnel of the detector section, see FM 4-145.

■ 116. PREPARE FOR ACTION.—*a.* As the vehicles of the detector-searchlight section reach the vicinity of the proposed position, the chief of section commands: **PREPARE FOR ACTION**, and indicates the locations for the machine gun, the detector mount and power trailer, the searchlight, the control station, the power plant, and the parking area for the vehicles.

b. No. 4 drives truck No. 2 to the power plant position where he and No. 6 uncouple the power plant. They unload the two-way radio, complete in frame with dynamotor, the remote control unit, the antenna, the coil of telephone wire, and the field telephone. No. 4 drives on to the machine-gun position leaving No. 6 to connect the battery cables of the radio to the power plant battery, to insert the antenna in the insulator, and to prepare the radio for communication.

c. No. 5 drives truck No. 1 to the vicinity of the searchlight position where he and the searchlight commander uncouple the trailer. Then the searchlight commander and No. 5 leave truck No. 1 and join the remainder of the squad, with the exception of No. 6, at the machine-gun position.

d. Under the supervision of the searchlight commander, Nos. 1, 2, 3, 4, and 5 lift down the assembled machine gun, and No. 3 immediately resumes the gunner's position. Nos. 1, 2, and 5 and the searchlight commander go to truck No. 1, and No. 4 drives truck No. 2 to the parking area where he inspects and camouflages it.

e. No. 5 drives truck No. 1 to the control station position, and on the way the red cable from the searchlight to the control station is laid by Nos. 1 and 2 under the supervision of the searchlight commander. No. 1 in the rear of the

truck pays out the red cable to No. 2 who walks behind. At the control station, Nos. 1, 2, and 5 and the searchlight commander unload and set up the control station (par. 74). The searchlight commander levels it and prepares the station for action. Nos. 1, 2, and 5 drive off in truck No. 1 to lay the yellow cables from the searchlight to the power plant.

f. After all cables have been laid No. 1 relieves No. 3 on the machine gun, No. 5 drives truck No. 1 to the parking area where he inspects and camouflages it, and No. 2 joins No. 3 and the searchlight commander at the searchlight trailer. These men unload the searchlight from the trailer (par. 73). They assist No. 3 in setting up and leveling the light. No. 3 connects the red and the yellow plugs in their receptacles, removes the extended hand controller and places it near the light. No. 2 returns to the control station and connects the red cable at the control station.

g. No. 4 returns from the parking area to the power plant, where he connects the yellow cables (par. 75b). No. 5 returns from the parking area to relieve No. 1 from the machine gun, No. 1 returning to the control station. No. 6 has already prepared the two-way radio for communication, including the field telephone connection to a position near the detector, and he has connected his field phone and established radio contact with the platoon CP. He then reports condition of remote control radio communication to the chief of section. (If the platoon's communications include a telephone net, No. 6 connects a field phone to the end of the wire laid to the position.)

h. Under the supervision of the chief of section the searchlight squad, with the exception of No. 6 (at the radio) and No. 5 (at the machine gun), assists the detector section in its preparation for action.

■ 117. EXAMINE EQUIPMENT.—*a.* The chief of section commands: EXAMINE EQUIPMENT, as soon as all items of equipment are in their proper positions and all cables are connected. At this command, he verifies the proper functioning of all equipment and supervises the orientation and synchronization of the detector with the associated searchlight equipment.

b. The searchlight commander inspects the power plant,

radio, searchlight, machine gun, and control station, paying special attention to the latter. He supervises the orientation of the light with the detector and the control station with the light as described in paragraphs 83 to 86, inclusive. He supervises the synchronizing of the elevation and azimuth zero reader systems, making sure that movements of the control station handwheels cause the zero reader needles to move in the proper direction.

c. Nos. 1 (azimuth controller) and 2 (elevation controller) examine the control station. They test the functioning of the distant electric control by elevating and traversing the light from the control station. They assist in orienting the control station with the light as described in paragraphs 83 to 86, inclusive.

d. No. 3 (searchlight operator) examines the searchlight and sees that all plugs are properly connected in receptacles; that the searchlight is leveled and properly connected for distant electric control; that spare positive and negative carbons are on hand; and that new or nearly new carbons are in place in the lamp mechanism. If the tactical situation permits, he strikes the arc and observes the voltmeter, ammeter, and ground glass finder to see that the arc is functioning normally. In making this test he covers the light with tarpaulin or a piece of canvas. He extinguishes the arc as soon as possible. He examines the extended hand controller. Under the supervision of the searchlight commander, he orients the light with the detector as described in paragraphs 83 to 86, inclusive, synchronizes the zero reader system by adjusting the azimuth and elevation receivers on the light, and orients the light with the control station.

e. No. 4 (power plant operator) examines the power plant, sees that the gasoline, oil, and water supplies are correct, and that the yellow cable plugs are properly connected. He starts the motor and builds up the voltage to the required no-load value. With the searchlight unit equipment all connected, he closes the main switch. The instruments should now indicate the proper tracking load values. If the arc is struck, he notes that the instruments indicate the proper arc load values (see Operator's Manual).

f. No. 5 examines the functioning of the machine gun, the water pump and connections. He checks the supply of ammunition.

g. No. 6 (telephone operator) tests communication with the platoon command post and with the remote control telephone. If communications are not functioning properly, he reports the fact to the chief of section.

h. No. 7 performs any assigned duties.

i. When all equipment is in order, the chief of section directs No. 6 to report, "Light No. _____ in order," to the platoon command post.

■ 118. STAND BY.—*a.* STAND BY is given by the chief of section when a target is detected, when an adjacent searchlight goes into action, or on order from the platoon command post. The command is generally followed by a target designation. The chief of section sees that all men are alerted and at their posts and supervises preparations to go into action. He directs the detector crew in the search for the target in the designated searching sector. When the target has been definitely located by the detector operators, he reports to the platoon command post, "Light No. _____; azimuth _____ mils; range _____ yards."

b. The searchlight commander repeats the command STAND BY. When power is on all lines, and power plant, searchlight, and control station are ready for action, he reports, "Light standing by," to the chief of section. When the detector is tracking the target, he causes the elevation and azimuth controllers to direct the darkened searchlight by zeroing the zero readers at the control station.

c. Nos. 1 and 2 stand at their posts at the control station. As soon as the zero reader pointers move consistently, indicating that the detector is tracking the target, they center the zero reader pointers by moving their handwheels the necessary amount and direction.

d. No. 3 takes post at the searchlight and awaits orders. He checks the voltmeter reading. If it is not correct he notifies the power plant operator.

e. No. 4 starts the power plant motor; builds up the voltage to the proper no-load value; closes the switches; and when

the instruments record the proper tracking load, he reports, "Power plant ready," to the searchlight commander.

f. No. 5 maintains watch at the machine gun.

g. No. 6 remains at the radio ready for further messages.

h. No. 7 performs any assigned duties.

■ 119. **TRACK.**—*a.* The command **TRACK** is given by the chief of section when the detector crew reports "On target." At frequent intervals he causes the azimuth and range of the target to be reported to the platoon CP, or to the plotting board of the central controlling agency.

b. The searchlight commander repeats the command and causes the azimuth and elevation controllers to point the darkened light by continuously centering the zero readers.

c. Nos. 1 and 2 continuously center the zero readers by turning the azimuth and elevation handwheels on the control station.

d. No. 3 stands by at the searchlight ready to strike the arc. He observes his instruments, noting that the voltage is at the proper value.

e. No. 4 keeps the power plant operating on tracking load, checking his instruments to see that the voltage and current remain at the proper value.

f. No. 5 continues on the alert at the machine gun.

g. No. 6 stands by at the radio for further messages.

h. No. 7 performs any assigned duties.

■ 120. **IN ACTION.**—*a.* The command **IN ACTION** is given by the chief of section (who may receive it over the radio from the platoon command post).

b. The searchlight commander repeats the command **IN ACTION** and causes Nos. 1 and 2 to commence an immediate search for the target, when necessary, using their respective handwheels. He observes the light beam through the binoculars, being especially watchful for flicks. He calls "Data," whenever he wishes Nos. 1 and 2 to center the zero readers exactly. When the target is flicked, he commands: **FLICK**, takes over personal operation of the control station from the controllers, and carries the target until it is out of range or until directed otherwise. If he receives the command **IN ACTION** before the detector has found the target, he causes

the controllers to search at the intersection of other beams until the light is on target.

c. Nos. 1 and 2 search by moving their zero reader pointers first to one side and then to the other of the zero position, centering exactly when the searchlight commander calls "Data." When the airplane is illuminated, they withdraw from the control station so as to avoid interference with the control of the beam by the searchlight commander.

d. No. 3 closes the main arc switch. He keeps watch on his instruments, seeing that the arc operates at 78 volts and 145 to 150 amperes. He recarbons the arc at the first break in operations after the positive carbon is about half consumed (usually after about 45 minutes of operation).

e. No. 4 continues to operate the power plant, checking to insure that the current and voltage are at the proper full-load value. (See Operator's Manual.)

f. No. 5 stands guard at the machine gun.

g. No. 6 stands by at the radio. He watches the sky, reporting all flicks and illuminations to the chief of section.

h. No. 7 performs any assigned duties.

■ 121. CHANGE TARGET.—a. The command CHANGE TARGET, followed by the designation of the new target, will be given by the chief of section (or received from the platoon command post). The chief of section directs the detector crew to point the detector in the direction of the new target. If the target is not already illuminated, he causes the personnel to search for and pick up the new target in the usual manner.

b. The searchlight commander repeats the command. He causes the control station crew to center their zero readers, thereby pointing the light in the direction of the new target.

c. Nos. 1 and 2, at the direction of the searchlight commander, center their zero readers, thereby pointing the light in the direction of the new target. During search, pick-up, and carry, they operate in the usual manner.

d. Nos. 3 and 4 stand by for further orders.

e. No. 5 stands by at the machine gun.

f. No. 6 stands by at the radio.

g. No. 7 performs any assigned duties.

■ 122. OUT OF ACTION.—*a.* The command OUT OF ACTION is given by the chief of section (or received from the platoon command post).

b. The searchlight commander repeats the command and causes the control station crew to continue centering the zero reader pointers.

c. Nos. 1 and 2 continue to center the zero readers.

d. No. 3 opens the main arc switch, extinguishing the arc, stands by the light, ready to close the arc switch on command, and observes the voltmeter to see that proper tracking load voltage is maintained (100 volts). He recarbons if necessary. No. 4 continues to operate the power plant, checking to see that the proper voltage and current for the tracking load are maintained.

e. No. 5 continues to maintain watch at the machine gun; No. 6 stands by at the radio; No. 7 performs any assigned duties.

■ 123. REST.—*a.* When no action is imminent, or when ordered by the platoon commander, the chief of section commands: REST. The command is repeated by the searchlight commander. For rest periods the chief of section arranges the relief schedule for the detector personnel and, with the searchlight commander, arranges the men from the searchlight squad in reliefs for these various necessary positions.

1. Telephone operator.

2. Power plant operator.

3. One man at machine gun and another close by at all times.

b. The chief of section will divide the hours of darkness with the searchlight commander, so that one or the other is definitely in command at all times.

c. Nos. 1 and 2 take their turns as replacement for the telephone operator at the radio. They watch the sky, not only for aircraft, but also for the beams of other searchlights.

d. No. 3 relieves No. 4 at the power plant as directed.

e. Nos. 1, 2, 3, and 4 may all be assigned as relief machine gunners. The detector section, too, should be able to supply men for the relief of the machine gunner.

f. Those members of the section crew not on duty remain in the vicinity of the equipment they are to man so that they may go into action with a minimum of delay.

■ 124. MARCH ORDER.—*a.* When it is desired to prepare the detector-searchlight section for movement on the road, the chief of section commands: MARCH ORDER. The command is repeated by the searchlight commander.

b. At this command, No. 4 prepares the power plant for traveling. He then goes to the machine gun to relieve No. 5. While No. 5 is bringing truck No. 1 from the parking area, No. 3 prepares the light for traveling. Nos. 1 and 2 disconnect the control station end of the red cable and pack the binoculars, the binocular mount, and the open sight in the binocular mount box.

c. No. 5 drives truck No. 1 to the power plant where he is joined by Nos. 1, 2, and 3. They reel in the yellow cables from the power plant to the searchlight, No. 1 walking behind the truck, No. 3 feeding the cables onto the reel, and No. 2 cranking the handle. From the searchlight, they drive to the control station, which they disassemble, load on the truck, and fasten in traveling position (par. 93). Truck No. 1 then moves to the searchlight position, and the red cable from the control station to the searchlight is reeled in by No. 2, assisted by Nos. 1 and 3.

d. No. 1 relieves No. 4 from the machine gun to go to the parking area for truck No. 2. At the searchlight, Nos. 2, 3, and 5, and the searchlight commander load the searchlight in the trailer and fasten it in traveling position by means of the turnbuckles provided (par. 94). The searchlight commander, and Nos. 2, 3, and 5 bring the trailer to the horizontal, prepare it for the road, and couple it to the truck.

e. Truck No. 2, having been returned from the parking area, is left in a position convenient for the loading of the machine gun. Meanwhile, the searchlight squad, with the exception of No. 6 (at the radio) and No. 1 (at the machine gun), assists the detector section in whatever duties the chief of section may direct. When the detector section is almost ready for the road, Nos. 1, 2, 4, and 5 return to truck No. 2 and under the supervision of the searchlight com-

mander and with the assistance of No. 3, load the ammunition chests, the water pump, and the complete machine gun.

f. (1) Unless specific instructions to the contrary are given by platoon or higher headquarters, communication is maintained to the last possible moment. Even after MARCH ORDER has been given, the platoon commander may wish to send out last minute changes or instructions.

(2) When directed by the chief of section, No. 6 reports to the platoon command post, "Light No. ——— closing station." He receives any final instructions, then prepares the radio for traveling. With No. 4 he loads the assembled radio and accessories into truck No. 2. If the platoon's communications include a telephone net, No. 6 disconnects his field phone from the end of the wire. He assists No. 4 in coupling power plant to truck. No. 4 drives the truck to its position behind truck No. 1.

SECTION IV

NOTES ON SERVICE OF THE PIECE

■ 125. GENERAL.—a. The service of the piece for antiaircraft searchlights *cannot* be conducted with the snap and precision of a formal drill. There are so many delicate mechanisms and electrical devices involved that an attempt to speed up the operations of PREPARE FOR ACTION and MARCH ORDER will result only in a great number of matériel failures.

b. It will rarely be necessary to execute PREPARE FOR ACTION or MARCH ORDER with great speed. *In all training, stress should be laid on the saving of time during the operation of locating the target by the detector, that is, between the time the first echoes are received and the time the set is smoothly tracking the target and transmitting data to its associated equipment.*

c. The service of the piece is conducted at ease and with as few orders as possible. Except for the necessary orders, reports, and instructions, no talking is permitted.

d. The service of the piece as described in the previous section and tabulated in the drill table, chapter 8, gives only an outline of the duties of each man at the various commands. A knowledge of what to do must be supplemented

by continuous practice until the unit can operate, if necessary, without commands. The procedure in locating, picking up, and carrying the target must become second nature if the platoon is to be capable of coping with multiplane attacks, and other stratagems of an attacking air force.

■ 126. MARCH ORDER.—It is necessary to exercise special care at MARCH ORDER, as this command is generally given at dawn, when crews are tired, hungry, and anxious to get back to bivouacs. Noncommissioned officers must exercise the supervision necessary to prevent damage to the matériel, both during the preparation of the matériel for the road and the securing of the matériel in the vehicles.

■ 127. COMMANDS AND SIGNALS.—Commands are given in the prescribed form, signals (buzzer, flashlight, or whistle) being substituted for commands wherever practicable.

■ 128. SAFETY PRECAUTIONS.—*a.* Searchlight operators should not enter the light when the main arc switch is on. When entering the light while the lamp is hot, the operator should be fully clothed and should wear protective gloves to avoid injury.

b. Crews loading and unloading the matériel on and off the trucks and trailers must keep clear of the equipment being loaded or unloaded, so that no one will be hurt if a block and tackle, winch, or cable fails.

■ 129. HANDLING EQUIPMENT.—*a.* Since much handling of equipment takes place under cover of darkness, special care must be exercised to avoid injury to personnel and damage to matériel.

b. As soon as matériel is unloaded from trucks it should be moved off the road. Matériel disassembled for loading should not be left in the road unless under guard. Cables should be thrown to the side or off the road so as to avoid damage by vehicles; tractors or tanks passing over a cable will completely destroy it.

c. Chauffeurs must exercise special care when moving without lights, or with blackout lights, to avoid damage to equipment or injury to personnel. When backing the truck, if this is necessary, the chauffeur should be assisted by

another member of the crew who walks in advance of the truck.

■ 130. ACTION ON THE MARCH.—*a.* Members of the searchlight section are given instructions relative to the action to be taken if attacked while on the march. The detector-searchlight section, with a number of heavy vehicles, is a fairly profitable target for low-flying light bombardment aviation, while units the size of a platoon or larger are most vulnerable to attack.

b. While on the road, the detector-searchlight section is defended by the caliber .50 machine gun which is set up ready for action in the rear of truck No. 2 of the searchlight squad. It may be necessary to remove bows and one side of the truck in order to secure freedom of action and an all around field of fire. Sandbags may be placed on the legs of the tripod mount to give stability. No. 3 acts as gunner, and is relieved by Nos. 1 and 2 who keep watch for hostile airplanes. When the unit stops along the road, the gunner remains at his post in the truck so as to give protection to the halted vehicles.

■ 131. FALL OUT.—At drills and practice and in the field when ample warning of the approach of targets may be expected, the platoon commander may give the command FALL OUT. At this command, all members of the section may leave their posts except the telephone operator who remains close to the radio, the machine gunner, and at least one operator (azimuth operator) of the detector section.

■ 132. DISMISSED.—When searchlights are to occupy the same positions on successive nights, the platoon commander at daylight gives the chiefs of section instructions as to the securing of equipment, posting of guards, or use of vehicles as may be necessary, and commands: DISMISSED. The personnel of the platoon is assembled at its bivouac, sometimes with that of a gun battery, for meals and rest. More often, the men remain at the section position, or in a nearby concealed position, and are served hot rations from the platoon mess.

CHAPTER 7

CARE AND MAINTENANCE; DEMOLITION

	Paragraphs
SECTION I. Care and maintenance of searchlight equipment_	133-135
II. Demolition of searchlight equipment.....	136

SECTION I

CARE AND MAINTENANCE OF SEARCHLIGHT EQUIPMENT

■ 133. GENERAL.—*a.* The maintenance of the matériel of the detector-searchlight section requires the intelligent care and handling that any competent mechanic will give to any piece of fine machinery placed in his care. It should be maintained in serviceable condition in accordance with the best electrical and mechanical equipment practice. Such maintenance provides for longer life and more efficient operation of the various units, and may save shutdowns for repairs during operating periods.

b. As the searchlight equipment may be operated at irregular intervals, and under wide variations of climatic conditions (excessive moisture, heat, cold, sand, salt air, dust), it is impossible to state the exact intervals of time which should elapse between successive oilings. The various parts of the equipment should be oiled as necessary.

c. Complete details for the care and maintenance of searchlight equipment, including first and second echelon maintenance, may be found in the Operator's Manual for the searchlight with which the unit is equipped. Trouble shooting, adjustments, and replacements are also covered in this manual.

d. For a discussion of the care and maintenance of the detector, see FM 4-145.

■ 134. RESPONSIBILITY FOR MAINTENANCE.—*a.* First echelon maintenance is the responsibility of the assigned operators

of the equipment. This maintenance includes proper operation and handling of the equipment, cleaning and lubrication. The operators work under the direction of the antiaircraft searchlight electrician of the battery maintenance section, and keep daily records of all maintenance performed.

b. Second echelon maintenance is the responsibility of the searchlight electrician and other trained personnel. The work is performed as outlined in the Operator's Manuals. A service record is kept for each unit of equipment.

■ 135. MAINTENANCE CHART.—The following chart of first echelon maintenance will serve as a practical guide for checking the services to be done, and the time interval at which each service is performed.

MAINTENANCE CHART

SPERRY SEARCHLIGHT M1941

WHEN NEEDED AS DETERMINED BY INSPECTION

<i>Point to be checked</i>	<i>Service rendered</i>	<i>Method used</i>
Mirror	Clean.	Cotton and cleaning solution supplied with equipment.
Drum	Clean.	Cloth.
Jackscrews	Clean.	Gasoline, if gritty.
Chassis	Clean.	
	Check for loose bolts.	
	Check for rust.	
Tires	Check for 35 lb.	
Lamp gears and feed rollers	Lubricate.	Aquadag, when lamp is hot.

AFTER EVERY OPERATION

Front glass	Clean.	Wipe inside with soft cloth.
Mirror	Clean.	Camel hair brush. Use lightly.

AFTER THREE CHANGES OF CARBONS

<i>Point to be checked</i>	<i>Service rendered</i>	<i>Method used</i>
Negative con- tacts	Clean.	No. 00 sandpaper wrapped once around negative carbon stub.

AFTER 10 HOURS OF OPERATION

Thermostat lens	Clean.	Soft cloth.
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AFTER 10 CHANGES OF CARBONS

Positive con- tacts	Clean.	Remove from lamp. Brighten surfaces with No. 00 French emery paper wrapped once around positive car- bon stub.
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SPERRY CONTROL STATION M1941

WHEN NEEDED AS DETERMINED BY INSPECTION

Jackscrews	Clean.
Azimuth gear and pinion	Clean.
Binocular mount sleeve	Clean.
Binocular column	Clean.

SPERRY POWER PLANT M1941

DAILY

Check: Gas
 Engine oil
 Water or antifreeze
 Battery water
 Tires
 Lights
 Hand brake and break-away chain

AS NEEDED AS DETERMINED BY INSPECTION

<i>Point to be checked</i>	<i>Service rendered</i>	<i>Method used</i>
Chassis and housing	Clean. Check for rust. Check for loose bolts.	

GENERAL ELECTRIC SEARCHLIGHT M1941

WHEN NEEDED AS DETERMINED BY INSPECTION

Mirror	Clean.	Cotton and cleaning solution supplied with equipment.
Thermostat mirror	Clean.	Same as large mirror.
Drum	Clean.	Cloth.
Jackscrews	Clean.	Gasoline, if gritty.
Chassis	Clean. Check for loose bolts. Check for rust.	
Tires	Check for 35 lb.	

AFTER EVERY OPERATION

Front glass	Clean.	Wipe inside with soft cloth.
Thermostat window	Clean.	Wipe with soft cloth.
Mirror	Clean.	Camel hair brush used lightly.

AFTER 3 TO 4½ HOURS OF OPERATION

<i>Point to be checked</i>	<i>Service rendered</i>	<i>Method used</i>
Negative contacts	Clean.	Cleaning stone.
Bevel gears in lamp mechanism box	Lubricate.	Ball bearing grease.
Lamp positive drive gearing (helical gears)	Lubricate.	Gredag.
Lampgears and feed rollers	Lubricate.	Aquadag, when lamp is hot.

AFTER 15 HOURS OF OPERATION

Positive brushes	Clean.	Cleaning stone.
Positive nose cap	Clean.	Reamer.

GENERAL ELECTRIC CONTROL STATION M1941**WHEN NEEDED AS DETERMINED BY INSPECTION**

Tripod top	Clean.
Jackscrews	Clean.
Azimuth gear and pinion	Clean.
Binocular mount sleeve and gear	Clean.
Binocular column	Clean.

GENERAL ELECTRIC POWER PLANT M1941

Maintenance is the same as that of the Sperry power plant M1941.

SECTION II**DEMOLITION OF SEARCHLIGHT EQUIPMENT**

■ 136. DEMOLITION OF SEARCHLIGHT EQUIPMENT.—*a.* Tactical situations may arise which will necessitate the demolition of matériel. During a retreat, limitations of time or transpor-

tation may make it impossible to evacuate all equipment. If the enemy is successful in surrounding the searchlight unit *and capture is imminent*, equipment must be destroyed or made useless to the enemy. Plans made should be flexible. The working principle to be followed is: demolition will be undertaken only on competent orders and then should be as complete as the available time, equipment, and personnel permit. If time does not permit thorough destruction of all parts, at least the important features of the matériel should be destroyed, and parts essential to the unit's operation ruined or removed. The same essential part should be destroyed on all like units to prevent the enemy's constructing one complete unit out of several damaged ones.

b. The following methods are suggested for the effective demolition of searchlight equipment in the field:

(1) *Searchlight*.—(a) Use an ax or sledge to completely smash all external electrical equipment, such as lamp control mechanism, arc controls, azimuth and elevation controls, zero readers and other meters, resistors, cable receptacles, and cables.

(b) Break the glass and throw a hand grenade into the drum. If grenades or other explosives are not available, use an ax or sledge, or a concentrated burst of caliber .50 machine-gun fire to gain the same effect. Make certain that the lamp head is destroyed and that the mirror is thoroughly distorted and perforated.

(c) If incendiary grenades are available, ignite one under each tire. If not available, fire a concentrated burst with the caliber .50 machine gun into each tire, and/or douse with gasoline and ignite.

(2) *Control station*.—(a) Remove the cover from the control unit and destroy all electrical equipment with an ax or sledge. Gasoline may then be poured into the unit and ignited.

(b) Remove the binoculars. If possible to evacuate, carry the binoculars. If not, smash them with an ax or sledge.

(3) *Cables*.—(a) Smash all receptacles and plugs.

(b) Heap cables into a pile, douse with gasoline, and ignite. If time is available, cut cables into short lengths before burning.

(4) *Sound locator*.—(a) Smash the acoustic corrector and all electrical equipment with an ax or sledge.

(b) Smash each horn in the same way.

(c) If time and materials are available, pour gasoline over the horns and corrector mechanism, and ignite.

(5) *Radio*.—Destroy by smashing thoroughly with an ax or similar instrument. If time and materials are available, pour gasoline on the remains and ignite.

(6) *Power plant*.—(a) *If TNT and incendiary grenades are available*.—Smash the fire extinguisher. Place a 2-pound charge of TNT on top of the bell housing near the cylinder wall of the engine. Use tetryl nonelectric caps and approximately 5 feet of safety fuze. Place one incendiary grenade under each tire. Smash the gasoline tank open. Ignite the incendiary grenades and the safety fuze. Observe a 200-yard safety zone around the power plant if TNT is used.

(b) *If TNT is not available*.—Smash all the electrical equipment and fire extinguisher in the generator section. Demolish the important parts of the engine (such as cylinder block, distributor, carburetor, radiator, cylinder heads, and manifolds) by smashing with an ax or sledge or by caliber .50 machine-gun fire. Ignite an incendiary grenade, if available, under each tire. If not available, damage the tires with an ax, pick, or caliber .50 machine-gun fire, and/or douse with gasoline and ignite.

(7) *Vehicles*.—(a) *If TNT and incendiary grenades are available*.—Smash the fire extinguisher. Place a 2-pound charge of TNT on top of the clutch housing. It is necessary to open the hood to do this properly. Use tetryl nonelectric caps and approximately 5 feet of safety fuze. Place an incendiary grenade under each tire. Smash the gasoline tank open. Ignite the incendiary grenades and the safety fuze. Observe a 200-yard safety zone.

(b) *If TNT is not available*.—Smash the fire extinguisher and the vital parts of the engine (see (6) (b) above). Open the crank case drain plug. Ignite an incendiary grenade, if available, under each tire. If not available, damage the tires with an ax, pick, or caliber .50 machine-gun fire, and/or douse with gasoline and ignite.

(c) The tires on the searchlight trailer should be destroyed as outlined above.

(8) *Caliber .50 machine gun.*—This should be the last item in the searchlight unit to be destroyed. It should be evacuated if at all possible.

(a) *Gun.*—Detach water chest and fire a burst into it. Field strip the gun. Use barrel as sledge. Raise cover; lay bolt in feedway; lower cover on bolt; smash cover down over bolt. Deform backplate. Wedge buffer into rear of casing allowing depressors to protrude; break off depressors by striking with barrel. Lay barrel extension on its side, hold down with one foot, break off the shank. Deform casing by striking side plates just back of feedway. Elapsed time 3½ minutes.

(b) *Mount M3.*—Use machine-gun barrel as a sledge. Deform pintle yoke. Deform traversing dial. Fold rear legs and deform so as to prevent unfolding. Remove front leg and knock off yoke. Extend elevating screw and bend screw by striking with barrel. Turn mount over; deform head assembly and knock off dial locking screw and pintle lock. Elapsed time 3 minutes.

(9) *Detector.*—For methods of demolition for the detector and its power plant, see FM 4-145.

CHAPTER 8

DRILL TABLE

■ 137. GENERAL.—The following drill table outlines the duties of the chief of section, and the drill of the searchlight squad of the detector-searchlight section. For the performance of duties by the personnel of the detector section under this drill table, see FM 4-145.

Table appears after index.

APPENDIX

LIST OF REFERENCES

■ 1. MANUALS.

Camouflage and protective measures_	FM 4-105, FM 5 -20
Care of matériel_	FM 4 -120
Chemical attack, defense against_	FM 21-40
Commands_	FM 4 -105
Communications_	FM 4-105, FM 24-5, FM 24-6, FM 24-10
Detector_	FM 4 -145
Distance between lights_	FM 4 -105
Driver training and selection_	TM 10-460, TM 21-300
Electrical fundamentals_	TM 1 -455
Examination for gunners_	FM 4 -119
(now published as FM 4-150)	
Explosives and demolitions_	FM 5 -25
Formations_	FM 4 -120
Gunner's instruction, antiaircraft searchlight batteries_	TM 4 -330
Identification of German aircraft_	FM 30-35
Identification of Japanese aircraft_	FM 30-38
Identification of U. S. government aircraft_	FM 30-30
Inspections_	FM 4 -120
Machine gun, Browning, caliber. 50, HB, M2	TM 9-226, FM 23-65
Machine gun fire, calculation of leads_	FM 4 -110
(now published as FM 4-112)	
Marksmanship and service of the piece, antiair- craft machine gun_	FM 4 -155
(now published as FM 4-135)	
Motor transportation_	FM 25-10
Organization_	FM 4 -105
Radio fundamentals_	TM 11-455
Radio operator, the_	TM 11-454
Radio set SCR-268_	FM 4 -145
Reference data_	FM 4 -118
(now published as FM 4-155)	

COAST ARTILLERY FIELD MANUAL

Service of matériel.....	FM 4-120
Sound locator M2.....	TM 9-2660, TM 9-1660
Tables of Organization, antiaircraft searchlight battalion:	
Mobile.....	T/O 4-35
Semimobile.....	T/O 4-135
Separate battalion.....	T/O 4-165
Tactical employment of searchlights.....	FM 4-105
Tactics and technique of the Chemical Warfare Service.....	FM 3-5
Theory of illumination.....	FM 4-171
(now published as FM 4-111)	
Training publications, list of.....	FM 21-6

For instructions for the operation of the unit's matériel see also the Operator's Manual which is issued with the individual element of equipment.

■ 2. FILMS.

Identification of aircraft—Characteristics and types of U. S. military airplanes.....	TF 1-258
Identification of aircraft—Distinguishing fea- tures of U. S. military airplanes.....	TF 1-259
Identification of aircraft (individual planes)— See FM 21-6 for list.	
The antiaircraft searchlight battery—Prepara- tion for action: Emplacement of equipment....	TF 4-195
The antiaircraft searchlight battery—Prepara- tion for use: Orienting and synchronizing....	TF 4-196
The antiaircraft searchlight battery—Prepara- tion for action: Drill of the searchlight section..	TF 4-197
The antiaircraft searchlight battery—Movement out of position: March order.....	TF 4-198
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The antiaircraft searchlight battery, care and maintenance of searchlight equipment—The battery.....	TF 4-380

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The antiaircraft searchlight battery—The searchlight section equipped with M1 trailers—Preparation for action.....	TF 4-398
The antiaircraft searchlight battery—The searchlight section equipped with M1 trailers—March order.....	TF 4-399
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Part II, 60" antiaircraft searchlight, Sperry M1941: Ventilating system—Zero reader follow-up system.....	FS 4-14
Part III, Sperry equipment: Distant electric control system, lamp and lamp control mechanism.....	FS 4-22
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RESTRICTED

ARTILLERY FIELD MANUAL

ANTI-AIRCRAFT ARTILLERY

OPERATION OF MATÉRIEL AND EMPLOYMENT OF PERSONNEL, SEARCHLIGHT UNITS

CHANGES }
No. 1

WAR DEPARTMENT
WASHINGTON, MARCH 27, 1943

FM 4-175, December 9, 1942, is changed as follows:

55. PRINCIPAL ELECTRIC CIRCUITS.

* * * *

c. Zero reader circuits.

* * * *

(4) The Sperry zero * * * zero voltage indicators. Therefore, some rectifiers must be used to convert a-c voltages into rectified a-c voltages. These rectifiers are * * * as the detector.

[A. G. 062.11 (1-5-43).] (C 1, Mar. 27, 1943.)

56. COMPARISON OF GENERAL ELECTRIC AND SPERRY SEARCHLIGHTS M1941.

b. * * *

ANTI-AIRCRAFT SEARCHLIGHTS—SPERRY M1941 AND GENERAL ELECTRIC M1941

Sperry M1941

General Electric M1941

* * * *

V. DISTANT ELECTRIC CONTROL (D. E. C.)

* * * *

C. D. E. C. switch * * *
(control station)

Purpose—to turn the D. E. C. system "ON" and "OFF".

VI. ZERO READER SYSTEM

A. Function

Indicates the relative positions of the detector and searchlight in azimuth and elevation.

* * * *

[A. G. 062.11 (1-5-43).] (C 1, Mar. 27, 1943.)

- | | |
|--|------------------------------------|
| 1. Motor amplidyne generator set and power motor feed switch (d-c power switch). | 4. Azimuth control box. |
| 2. Elevation control box. | 5. Azimuth amplidyne. |
| 3. Arc switch. | 6. Elevation amplidyne. |
| | 7. Steel drum. |
| | 8. Elevation servo amplifier unit. |

FIGURE 15.—General Electric searchlight, M1942—showing amplidyne generators.

[A. G. 062.11 (1-5-43).] (C 1, Mar. 27, 1943.)

SEARCHLIGHT UNITS

■ 59½. (ADDED) SPREAD BEAM SEARCHLIGHTS.—*a. General.*—

(1) All AA searchlights have additional means of tactical employment due to the adoption of a modification which permits the searchlight beam to be spread from a narrow beam of $1\frac{1}{4}^{\circ}$ to a maximum spread of 15° . The spreading of the beam is accomplished by a modification of the lamp head and control rod which permits the lamp head to be displaced $4\frac{1}{2}$ inches to the rear of the normal focal point. The lamp head may be moved from the in-focus position to the maximum flood position in 2 seconds, and returned in the same time to its normal position at the focal point of the mirror. It may be stopped on any desired point within the limits of its movement. Upon the return of the lamp head to its forward position it may be made to stop at the correct in-focus point for the standard long range $1\frac{1}{4}^{\circ}$ beam. The operation of the electro-mechanical feed system, by which the positive carbon is fed forward as it burns back, is not affected by the addition of the spread beam device.

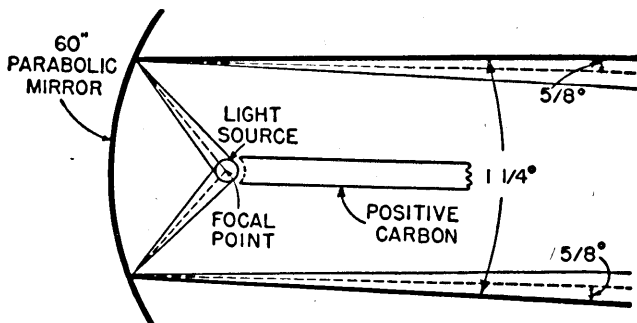
(2) The spread beam searchlight will be employed in the illumination of low-flying targets for engagement by automatic weapons, machine guns, and small arms. Additional uses are the illumination of the descent of parachute, glider, or air transported troops; illumination of landing strips or airdromes; illumination for defense against waterborne attack and landings; and illumination of hostile low-flying enemy aviation for interception by friendly fighter aircraft.

b. Modification kit.—Existing lights will be supplied with modification kits which will permit the searchlights to be modified for use as spread beam lights by the battery maintenance section. This modification may be accomplished on either the Sperry or General Electric 60-inch searchlight in about 2 hours.

c. Optical principles of beam spreading.—(1) *Normal beam.*—The standard 60-inch Army searchlights employ a metal mirror constructed in the form of a parabola. When light is emitted from a point source located at a specific point in front of the mirror's center axis, the parabolic reflecting surface of the mirror directs the reflected light from its surface in parallel lines. The point source which results in the reflection of rays of light in parallel lines is called the focal point of the parabolic

mirror. This principle of reflection is illustrated in figure 15½①. Due to the fact that the light's source at the focal point of the 60-inch Army searchlight is not a point source of light, but actually a translucent globule of luminous gas in the crater of the positive carbon, there is a beam spread of the reflected rays from the mirror of $1\frac{1}{4}^{\circ}$ (fig. 15½①).

(2) *Spread beam.*—The properties of the parabolic mirror are such that if the light source, the globule of gas, is moved along the focal axis of the mirror to a position closer to the mirror, then the reflected rays emitted from the mirror tend to spread



① Beam spread of a 60-inch AA searchlight (in focus).

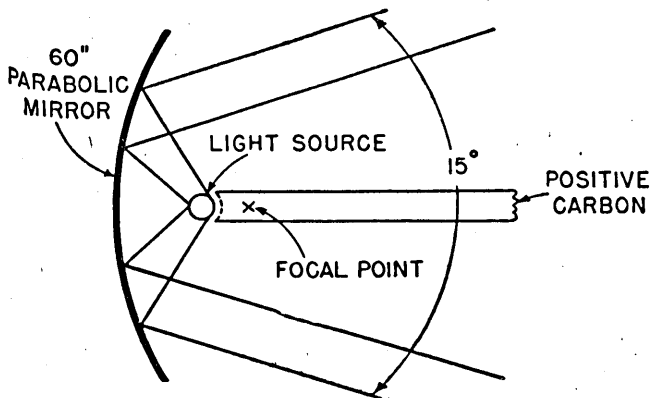
FIGURE 15½.

outward, and the degree of this spread is in direct ratio to the distance out of focus that the light source is moved, thereby accomplishing a variable beam spread. Figure 15½② illustrates a beam which has been spread by the movement of the source of light to the rear of the focal point of the mirror.

d. Mechanical features—(1) *General.*—In the models of both of the manufacturers of 60-inch Army searchlights the method of obtaining this displacement of the light source is a system of mechanical movement of the entire lamp head a maximum distance of approximately $4\frac{1}{2}$ inches toward the mirror. This plan employs the use of a rack and pinion head changing device, with a spreading handwheel for the actual turning of the pinion gear to drive the head to its new position.

SEARCHLIGHT UNITS

Both models of lights must also have an additional sliding coupling joint placed in each of the control rods to accommodate for the shortened length of each control rod which is due to the head being displaced toward the rear. The additional joints adjust the lengths of the control rods for the position of the lamp head, so that the feed mechanism may continue to operate the positive and negative carbons easily without any tendency toward jamming or sticking.

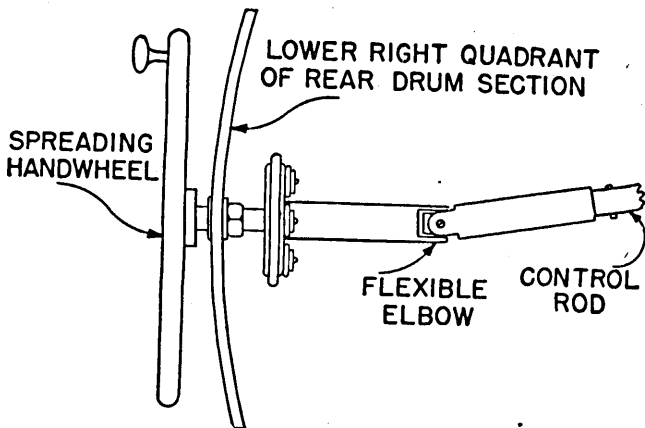


③ Beam spread of a 60-inch AA searchlight (lamp head moved $4\frac{1}{2}$ inches).

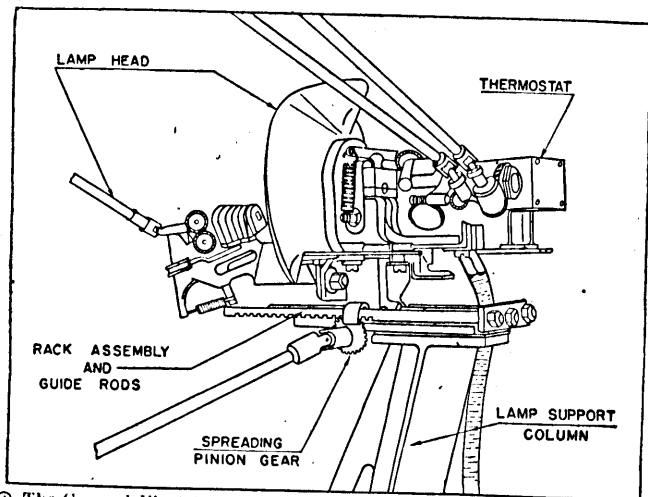
FIGURE 15½—Continued.

(2) *General Electric*.—The modification ~~ldt~~ for the General Electric light will employ a spreading handwheel installed even with the top of the right drum extension door opening, and which will be mounted through the wall of the drum itself with a handwheel of about 8 inches in diameter on the outside, and a flexible elbow on the inside (fig. 15½③).

At the lamp head, there are twin guide rods to insure exact movement forward and backward, with the driving pinion gear operating upon the right handwheel guide rod, which has teeth cut into its lower surface (fig. 15½④). The thermostat on the General Electric searchlight moves directly with the head and requires no modification whatsoever.



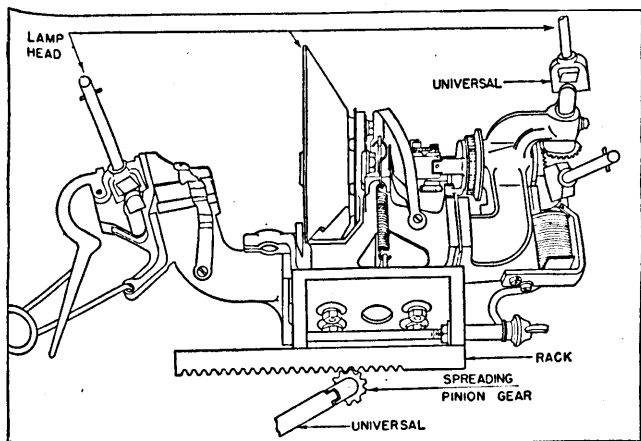
② Spreading handwheel mounted on lower right quadrant of the rear drum section, showing flexible elbow.



③ The General Electric lamp unit with spread beam device. Lamp head in spread beam position.

FIGURE 15½—Continued.

(3) *The Sperry searchlight.*—The Sperry system for spreading the searchlight beam is practically the same as that of the General Electric, except for a reduction gear case placed on the inside of the drum into which the handwheel rod will connect directly. The Sperry lamp head uses an extended rail and track to allow for this additional rearward movement and also employs a pinion gear driving directly onto a single rack, which



⑤ Schematic of the Sperry lamp unit with spread beam device. Lamp head in spread beam position.

FIGURE 15½—Continued.

[A. G. 062.11 (1-5-43).] (C 1, Mar. 27, 1943.)

is connected immediately below the center of the lamp head (fig. 15½⑤). The thermostat lens rod is changed slightly to provide a greater pivoting of the lens toward the rear, so that the light beam which actuates the thermostat, may be correctly focused into the window of the thermostat which remains in its normal position on the drum.

(4) *Modification kit.*—The modification kit will include complete instructions for installation of the spread beam device and will contain the following additional parts: necessary rack

and pinion, beam spread control rod, sliding couplings, spreading handwheel, universal bearing, and indicator pointers.

e. Operational characteristics.—(1) Present experience indicates that the spread beam searchlight will furnish sufficient illumination of the target at maximum spread to enable automatic weapons to fire at ranges of approximately 1,000 yards. Tables I, II, and III summarize certain operational characteristics of the spread beam and show the varying effects of the beam spread upon intensity of illumination (foot candles at 1,000 feet), upon range of illumination, and upon the diameter of the beam at varying distances from 1,000 to 10,000 feet.

(2) The spreading of the beam, even to a slight degree, substantially affects the intensity of illumination at the end of the beam and on the edges. As the extent of spreading increases, the intensity of illumination of all parts of the beam rapidly decreases, but notably in the central portions of the beam, the edges reaching out and illuminating an object at a considerably greater distance. Table I illustrates the relationship between the spreading of the beam and reduction in the intensity of illumination (at 1,000 feet).

TABLE I

Displacement from focal point	Intensity of illumination at center (foot candles)	Intensity of illumination on edges (foot candles)
In focus.....	440	
1" flood.....	22	48
2" flood.....	4	24
3" flood.....	1.4	10
4" flood.....	0.8	5.5
4½" flood.....	0.6	5.05

(3) As the beam is spread, the range of illumination of a target is rapidly reduced. Table II shows this relationship. It is a tabulation of the result of tests in which a medium

SEARCHLIGHT UNITS

sized, semicamouflaged, target was illuminated at 1,200 feet altitude.

TABLE II

Beam spread (degrees)	Approximate displacement from focal point (inches)	Approximate ranges (yards)
1¼	0	15,000
2	1¼	4,800
4	1¾	3,200
6	2¼	2,200
8	2½	2,000
10	3	1,700
12	3¾	1,500
15	4½	1,250

(4) *Beam spread area.*—As the lamp mechanism is moved to the rear, the rays of the beam are diverged, and the area illuminated becomes greater although the intensity of illumination becomes less. In Table III, the illumination areas are tabulated for ranges from 1,000 feet to 10,000 feet for beam spreads of 1°, 2°, 4°, 6°, 8°, 10°, and 15°. These beam diameters are only approximate, and no attempt has been made to secure exact values.

TABLE III

BEAM DIAMETERS FOR VARIOUS BEAM SPREADS AND RANGES

Beam spread (degrees)	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
1	22	40	58	74	92	110	126	145	164	180
2	40	75	110	148	183	215	250	285	340	360
4	75	145	215	285	350	430	490	560	625	700
6	105	205	310	400	500	590	695	805	900	1,000
8	145	285	425	570	700	840	980	1,130	1,260	1,400
10	180	360	540	700	880	1,050	1,230	1,400	1,580	1,750
15	270	540	780	1,050	1,300	1,590	1,800	2,100	2,400	2,600

f. Training.—(1) *General.*—In setting up a program of training on the technique of spreading the searchlight beam, the fact that there is only so much light delivered from the searchlight must be considered. Therefore, a narrow beam of great range or a spread beam of short range may be obtained. The range of the searchlight beam is directly related to the degree of beam spread for which the searchlight is set. In training programs, it is suggested that a searchlight operator be given considerable experience in gaining the relation between the beam spread indicator on his handwheel to its position of rotation (as indicated by the index), and he should also be trained to compare mentally this position with the actual spreading of the beam in the sky and the resultant effect on the range of the beam. The training program should require that the operator actually engage in a definite training period in which he practices turning the handwheel quickly to produce a beam spread of a given value. This practice will enable him to change the spread of the beam rapidly and accurately when the proper signal is given. Such planned drills at specific times are necessary because searchlight crews are normally trained to keep the lamp head in the closest possible position of focus. Therefore, a new technique must be learned. The searchlight operator should be thoroughly drilled in listening carefully for the prescribed signal so that he may spread the beam promptly in accordance with the tactical situation. As many men as possible should be given the above training, as well as training in the recognition of the several signals for the operation of the lamp. By this method the members of the section will function as a complete team at all times, for they may be rotated in the various assignments, and accidents or casualties will have a minimum effect on the efficiency of the unit. It should be standard practice that the searchlight operator always rotate the lamp head to its $1\frac{1}{4}^{\circ}$ in-focus position when the light is put out of action, and the control station operators will thereby always know that the beam will be at its normal in-focus position.

(2) *Signal control.*—(a) It is suggested that a tentative buzzer signal system be adopted similar to the procedure outlined below. One buzz is given for IN ACTION or OUT OF ACTION,

depending upon whether the light is or is not operating at the moment the signal is given. The signal to spread the beam may be one long buzz and the operator will continue to rotate the beam spreading handwheel until the buzzer ceases. Two short buzzes given once will be a signal for narrowing the beam and when followed by continued groups of two buzzes each, the handwheel will be rotated until the groups of two buzzes stop, or the in-focus position is reached. Any practical buzzing code may be adopted. Daytime practices should include drill in buzzer or telephone codes, so that the searchlight commander and searchlight operator may be familiar with the signals to be used.

(b) In many cases a telephone signal system may be employed between the control station and the searchlight. The telephone system will probably provide a more rapid and reliable method for spreading the beam to the degree desired by the searchlight commander. Telephone orders may be given in degree values or in such terms as "wider," "narrower," or "hold."

(c) On any signal system the searchlight, as well as the control station, must be free to turn rapidly in azimuth. It will probably be necessary to use extended hand control against high angular rate targets.

(3) *Targets.*—(a) Various targets for training in the operation of the spread beam searchlight can be devised or provided for. To simulate low-flying bombers, arrangements may be made for a flying mission at 1,600 to 1,800 feet, using a tow line of 1,800 feet and an A6 flag target. It is suggested that this target be painted black or olive drab to simulate actual conditions. As only one light will normally be available in action, and as warning of an attack will come from the AAAIS or anti-aircraft lookouts no more than a few seconds before action begins, the searchlight unit should have prolonged practice in alerts for immediate action against airplanes from an unexpected direction. Drill should also be conducted in going into action from REST.

(b) When the function of the searchlight unit is to illuminate for automatic weapons fire, the searchlight operator should make it a practice to spread the beam on all approaching targets, even though actual orders for spreading the beam have not

been given, unless the target is too far away to illuminate effectively with the spread beam. In these drills, the searchlight operator should practice using the narrow beam, or the beam only slightly spread, to pick up the target at the maximum range and at a low angular rate of travel, then spreading the beam as the target approaches, and as the angular rate of travel increases. At all times the beam angle should be controlled so as to "just cover the target fully."

(c) For training of the unit for defense against parachute troops, dummy parachutes may be constructed and a flying mission arranged to drop the parachutes. The greatest benefit may be obtained from joint tactical exercises with the commanders of any local air-transported, glider, or parachute troops who may be training in the vicinity. By this means actual high speed targets are illuminated under conditions closely resembling those of battle. In these joint drills it is highly important that close radio communication be maintained between the airplane and the ground, so that there may be no danger of blinding the pilot of the target or towing airplane.

(d) If water areas are nearby, waterborne transports and landing parties may be illuminated, by making the necessary arrangements for such tactical exercises.

[A. G. 062.11 (1-5-43).] (C 1, Mar. 27, 1943.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,

Chief of Staff.

OFFICIAL:

J. A. ULIO,

Major General,

The Adjutant General.

DRILL TABLE Drill of the detector-searchlight section

Details	*Prepare for action	Examine equipment	Stand by	Track	In action	Change target	Out of action	Rest	*March order
Chief of section.....	Indicates locations for detector, searchlight, machine gun, control station, power plants and parking areas. Commands: PREPARE FOR ACTION. Supervises unpacking and assembly of detector.	Commands: EXAMINE EQUIPMENT. Supervises the examination and testing of operation of all units of detector matériel. Directs orientation and synchronization of the detector with associated equipment of the searchlight squad. Directs telephone operator (No. 6) to report, "Light No. — in order."	Gives or repeats command, STAND BY. Supervises detector search. When detector operators have located target, reports to CP, "Light No. —. Azimuth —. Range — yards."	Gives command: TRACK to detector section after they report, "On target." Causes azimuth and range to be reported to CP at frequent intervals.	When he estimates that the most favorable time for going into action has arrived, he gives or repeats command: IN ACTION.	Gives or repeats command: CHANGE TARGET. Causes detector crew to point detector in direction of new target.	Gives or repeats command: OUT OF ACTION. Causes detector crew to continue tracking pending further orders.	Commands: REST. Together with searchlight commander arranges schedules of relief on detector, telephone, machine gun, and power plants. Shares watch with searchlight commander.	Supervises disassembly and packing of units of detector matériel. Supervises preparation of detector section for the road. Instructs searchlight commander as to next move. Chief of section travels with detector personnel.
Searchlight commander.	Assists in uncoupling of searchlight trailer. Supervises unloading and setting up of machine gun unit, including water pump and ammunition chests. Assists in unloading and setting up of, first, control station and then searchlight. Supervises laying of red (15-conductor) cable from searchlight to control station, and of yellow (single conductor) cables from searchlight to power plant. Supervises connection of cables and arranges for connection of detector-searchlight cable (director-adaptor combination cable—No. 27 plus No. 28), laid by detector personnel.	Repeats command of chief of section, EXAMINE EQUIPMENT. Examines the searchlight, control station, machine gun, power plant, and radio. Under direction of chief of section, supervises orientation and synchronization of searchlight and control station. Orders power ON and checks D. E. C. and zero reader system. Reports, "Searchlight squad in order," to the chief of section.	Repeats command, STAND BY. Supervises preparations to go into action. When searchlight squad is ready for action, he reports, "Light standing by," to chief of section.	Repeats command. When chief of section has reported azimuth and range of target, he directs elevation and azimuth controllers to center pointers continuously on zero readers. Supervises elevation and azimuth controllers.	Commands or signals to No. 3: IN ACTION. Observes light beam through binoculars. Calls, "Data," when he wishes Nos. 1 and 2 to center zero readers exactly. When the target is flicked, he commands: FLICK , and takes over operation of control station, following target visually until out of range or until otherwise directed. If command IN ACTION is received before detector is on target, he searches near intersection of other beams until target is illuminated or detector is on target.	Repeats command: CHANGE TARGET. Causes crew of control station to center zero reader pointers. If target is not illuminated, he causes personnel to search for it and pick it up in the usual manner.	Commands or signals to No. 3: OUT OF ACTION. Causes Nos. 1 and 2 to take over and continue centering zero reader pointers.	Repeats command: REST. As directed by chief of section, arranges schedules of relief for personnel of searchlight squad. Shares watch with chief of section.	Receives and repeats command: MARCH ORDER. Supervises and assists in disassembly of control station, reeling of cables, loading of control station into truck No. 1 and loading of searchlight into trailer. Supervises coupling of trailer. Assists in loading of machine-gun matériel and supervises coupling of power plant. Inspects reeled cables, hold-down devices, break-away chains, and stop lights. Checks that electric brake jumper cords are connected. Reports to chief of section and confers on next move.
Azimuth controller, No. 1; Elevation controller, No. 2.	Help Nos. 3, 4, and 5 unload machine gun, water pump and ammunition chests. Join No. 5 and searchlight commander at truck No. 1 and move to control station position laying red cable en route. Help to unload tripod, control unit and binocular mount box and set up control unit on tripod. Drive to searchlight. With No. 5 lay yellow cables from light to power plant. No. 1 relieves No. 3 on machine gun. No. 2, with No. 3 and the searchlight commander, unloads searchlight from trailer, removes canvas cover, and levels light. No. 2 returns to control station when relieved from gun by No. 5.	Nos. 1 and 2 together examine control station and test D. E. C. by elevating and traversing searchlight. Both assist searchlight commander to orient and synchronize the control station and searchlight with the detector. After entire unit has been oriented and synchronized they verify that movements of azimuth and elevation handwheels produce movements of the zero reader needles in proper direction.	Nos. 1 and 2 stand at posts awaiting orders.	Nos. 1 and 2 keep zero readers centered.	Nos. 1 and 2 search, when necessary, by slowly moving their zero pointers first to one side and then to the other of the zero position. When the searchlight commander calls, "Data," they center the zero readers exactly. When he commands: FLICK , they withdraw to avoid interfering with control of the beam.	Nos. 1 and 2, at direction of the searchlight commander, center their zero reader pointers, thus pointing the light in the direction of the new target. Operate in the usual manner during search, pick-up and carry.	Nos. 1 and 2 operate azimuth and elevation handwheels and keep zero readers centered.	Nos. 1 and 2 take their turns at relieving other personnel as directed by chief of section. Stand by to man machine gun.	Disconnect red cable and stow away binoculars, binocular mount, and open sight in binocular mount box. Go to power plant and help No. 3 reel yellow cables into truck No. 1 between power plant and searchlight. Help load control station. Help reel in red cable as truck moves from control station to searchlight. No. 1 goes to machine gun and relieves No. 4. No. 2 goes to searchlight position and helps Nos. 3 and 5 and the searchlight commander load the light into the trailer and couple the trailer with truck No. 1. No. 2 goes to the machine gun position and helps Nos. 1, 3, 4, and 5 and the searchlight commander load the machine gun, water pump, and ammunition chests. Both Nos. 1 and 2 remain on truck No. 2 to man machine gun for the march.
Searchlight operator; machine gunner en route, No. 3.	Helps Nos. 1, 2, 4, and 5 unload machine gun, water pump and ammunition chests. Remains on alert at gun until relieved by No. 1. Goes to searchlight trailer and unloads light, assisted by No. 2 and the searchlight commander. Connects red and yellow cables and detector cable when delivered. Prepares searchlight for action.	Examines searchlight and verifies electrical connections. Sees that fresh carbons (positive with preformed crater) are in place in light mechanism. Assists in orienting and synchronizing. If allowable, tests light mechanism by turning arc ON. Verifies that spare carbons are on hand. Verifies that extended hand controller is close to light and ready for action.	Stands by at searchlight. Checks proper voltage on voltmeters.	Stands by at searchlight ready to strike arc.	Closes main arc switch on signal, thereby lighting searchlight. Keeps watch on instruments to see that arc operates at 78 volts and 150 amperes. Recarbons arc at first break in operations after positive carbon is half burned. NOTE.—For correct procedure, see Operator's Manuals for Sperry or General Electric.	Stands by on alert checking the functioning of searchlight.	On signal or command opens main arc switch, extinguishing the light. Stands by to close switch on order.	Turns arc OFF if ON. Relieves No. 4 at power plant as directed by searchlight commander.	Disconnects cable plugs from receptacles and prepares light for march. Goes to power plant and helps Nos. 1 and 2 reel yellow cables into Truck No. 1. Helps load control station. Helps reel in red cable. Helps load searchlight into trailer and couple trailer to truck No. 1. Helps load machine gun, water pump and ammunition chests into truck No. 2. Rides in truck No. 2 and mans machine gun on march.
Power plant operator and chauffeur, truck No. 2, No. 4.	Drives to power plant position. With No. 6, uncouples power plant and unloads two-way radio, complete in framework dynamotor. Drives to machine gun position and helps Nos. 1, 2, 3, and 5 unload machine gun, water pump and ammunition chests. Drives truck No. 2 to parking area, checks gas, oil and water and camouflages truck. Returns to power plant; connects yellow cables.	At power plant, checks gas, oil, and water supply. Starts motor and builds up required voltage. NOTE.—For correct procedure, see Operator's Manual.	Starts motor, builds up voltage to proper no-load value; closes switch, checks tracking load value, and reports "Power plant ready," to searchlight commander.	Continues at alert. Watches dials.	Checks that voltage is at proper full load value and amperage is correct.	Maintains watch on dials.	Checks that voltage is at proper tracking value.	Opens switch and shuts off motor at power plant. Stands by machine gun for surprise attack.	Shuts off motor and prepares power plant for march. Radio is left in operation. Disconnects yellow cables. Relieves No. 5 at machine gun. In turn relieved by No. 1. Goes to parking area for truck No. 2, drives to machine gun and assists in loading of machine gun, water pump, and ammunition chests. Drives to power plant station and helps to load two-way radio, and to couple power plant. Drives truck No. 2 to position on road behind truck No. 1.
Chauffeur, truck No. 1; machine gunner at emplacement; No. 5.	Drives directly to searchlight position and, with searchlight commander, disconnects searchlight trailer. Leaves truck No. 1 and helps Nos. 1, 2, 3, and 4 to unload machine gun, water pump and ammunition chests from truck No. 2. Returns to truck No. 1 and drives to control station position, laying red cable en route. Helps Nos. 1 and 2 and the searchlight commander unload tripod, control unit and binocular mount box and set up control unit on tripod. With Nos. 1 and 2 drives truck to searchlight and lays cable from there to power plant. Drives truck to designated parking area, checks gas, oil and water and camouflages truck. Returns to machine gun to relieve No. 1.	Stands by as machine gunner.	At machine gun.	On alert.	Alert at gun.	On alert.	Remains at post.	Stands by as machine gunner.	Relieved by No. 4 at machine gun, goes to parking area for truck No. 1. Drives truck from power plant to searchlight as yellow cables are reeled. Drives to control station. Helps load control unit, tripod and binocular mount box. Drives back to searchlight as red cable is reeled. Helps to load light into trailer and couple trailer. Leaves truck No. 1 to help load machine gun, water pump, and ammunition chests onto truck No. 2. Returns to truck No. 1 with searchlight commander, ready for the road.
Telephone operator No. 6.	Helps No. 4 uncouple power plant and unload two-way radio (assembled). Connects battery cables of radio to power plant battery; inserts antenna in insulator; prepares radio for communication. Connects telephone wire extension to remote control unit. Tunes in on designated frequency. Lays telephone wire to position near chief of section (for detector-searchlight section) or near searchlight commander (for searchlight squad); connects field telephone. Returns to radio **.	Tests functioning of remote control radio or telephone with platoon CP.	Repeats command and stands by for further messages.	On alert at radio.	Repeats command from platoon CP. Repeats all messages. Looks for target and reports illumination or flicks to searchlight commander.	Repeats command and stands by for further messages.	Repeats command. Stands by for further messages.	Remains at radio until relieved. Watches for and reports to chief of section adjacent lights in action.	Maintains contact with platoon CP until directed by chief of section or searchlight commander to report, "Light No. — closing station." Receives final instructions. Goes to telephone position. Disconnects telephone. Returns to power plant, picking up wire. Removes radio antenna and battery cables. Helps No. 4 load radio and couple power plant to truck.**

Basic No. 7

Performs duties as directed by searchlight commander.

NOTE.—In each of the two searchlight squads of the platoon which are not equipped with detectors, the searchlight commander is in charge of the squad. In each of these two squads, Nos. 1 and 2 are not required to center zero readers; therefore, they perform duties assigned by the searchlight commander.

NOTES

*At the direction of the chief of section, the searchlight squad, when completely prepared for action or prepared for the march, will assist the detector crew to set up or take down the detector. Communication and local protection will be maintained until the entire section is ready to move. Not until then will the machine gun unit and two-way radio be loaded into truck No. 2.

**If telephone wires have been established to the position, No. 6 connects the field telephone at end of wire line (PREPARE FOR ACTION) and disconnects telephone from end of wire line (MARCH ORDER).